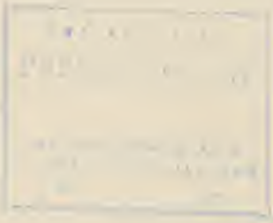

THE OLD STONE BRIDGE.

THE

PHOTOGRAPHIC NEGATIVE.

WRITTEN AS

A PRACTICAL GUIDE

TO THE PREPARATION OF SENSITIVE SURFACES BY THE CALOTYPE, ALBUMEN, COLLODION, AND GELATINE PROCESSES, ON GLASS AND PAPER, WITH SUPPLEMENTARY CHAPTERS ON DEVELOPMENT, ETC., ETC.

BY THE

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Author of Photographic Printing Methods, etc., etc.

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SCOVILL MANUFACTURING COMPANY. W. IRVING ADAMS, Agent.
1888.

CONTENTS.

PREFACE.

This book, like its companion, "Photographic Printing Methods," is the outcome of my wish to testify to the exceeding great interest which I take in photography, an interest which has been deepened by my study of the literature of the science and a growing knowledge of the many processes to which it has given birth.

Some few of those processes I endeavored to explain in my former volume. Others of equal interest I have selected for description in the following pages.

I have aimed to select only those methods known to have a permanent value.

If it be objected that some of them no longer have a practical value, let it be remembered that an acquaintance with them is necessary to a thorough knowledge and appreciation of the enormous advance which photography has made in these later years.

It is folly to neglect the treasures of past experience.

There is a culture, a completeness of knowledge, in this as in other sciences.

I have endeavored to make this knowledge easy of attainment by giving a few typical formulæ under each of the historical negative processes.

The arrangement of the chapters follows the historical or chronological order of the development of the negative process, from the calotype of Fox-Talbot to the pellicular film of to-day.

I make no other claim to originality than is implied in the selection and arrangement of the material at my command. The appended list of authorities bears abundant witness to my indebtedness to better workers in the same field.

I have sought to make a practical book, valuable alike to the amateur and to the professional, and I bespeak for my effort the kindly criticism which well-meant striving always merits.

To Dr. Charles Ehrmann and W. I. Lincoln Adams, of the *Photographic Times*, my thanks are due, as well for the warm interest which they have shown in the work, as for the valuable advice and assistance they have freely given.

It is with a feeling of regret that I bring to a close a task which has been full of pleasure and profit, and one which I trust may have a genuine, though, perhaps, a small value to my brother photographers, to whom I respectfully dedicate my work.

Rev. W. H. Burbank.

Newburg, N. Y., February, 1888.

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CHAPTER I.

GENERAL REMARKS ON SENSITIVE SURFACES, ETC.

It is proposed in this chapter to give a brief statement of the nature of the various sensitive compounds in most common use in photography, followed by brief notes on the manipulations common to all negative methods described in subsequent chapters.

Substances Sensitive to Light.—The number of substances which are sensitive to the action of light is infinite. There is reason to believe that there is no substance which is not more or less changed in outward appearance or in internal structure by the continued action of light.

But while this is true, thus far but three compounds have come into general use for the production of photographic negatives; these are the iodide, the bromide, and the chloride of silver; and more rarely, the fluoride of silver. These products of double decomposition are very far from possessing equal value in negative work.

The bromide of silver is the one of the three compounds which most perfectly meets all the requirements demanded by the varying needs of the photographer, which are that the result due to the action of light shall be effected as speedily as possible, that the tone values of different colors shall be reproduced on the plate as they are on the retina, and that the quantities of light which give the impression of high lights, half-tones, and shadows shall produce the same effect on the sensitive surface that they produce on the human eye.

As the result of much experiment and investigation, it has been found that while the iodide and the chloride possess one or more of these qualities in a higher degree than the bromide, the latter is superior to the others in that it meets fairly well

all the requirements. It is more sensitive, and gives a better rendering to half-tones than either of the others. For certain purposes, however, the iodide or the chloride may be advantageously substituted for the bromide, or combined with it. For the reproduction of plans, engravings, designs, etc., in line work, the iodide is superior to either of the others.

The chloride, owing to its comparative slowness, is but little used in negative work, but is invaluable for the production of positives on glass.

The fluoride of silver has been recommended by Obernetter and Vogel for orthochromatic plates.

Many formulæ are based on the combination in different proportions of the iodide and bromide, and, less often, the chloride, in order that the excellencies of one may counterbalance the defects of the others.

No difficulty will be experienced in effecting this combination if care be taken to have the amount of silver at least equal to the total of the combining weights of the salts.

The necessity for this is based on the law of chemical affinity. The iodides, bromides, and chlorides differ in the order named in their affinity for nitrate of silver. If a solution of nitrate silver be added gradually to a solution containing an iodide, a bromide, and a chloride, the iodide of silver will be formed first; next, the bromide of silver after all the soluble iodide has been converted, and after the conversion of the bromide, the chloride is formed.

So powerful is the law of affinity governing these combinations, that the precipitates formed will be decomposed, if necessary, to satisfy it.

If sufficient of a solution of chloride of sodium has been added to a solution of nitrate of silver to convert all the nitrate into the chloride, the latter will be decomposed and transformed into the bromide of silver, if a bromide solution is added, which in turn will be changed into the iodide of silver on the addition of an iodide solution.

The Film.—Owing to the impossibility of spreading the sensitive salt of silver formed by double decomposition when an iodide, a bromide, or a chloride solution is poured into a

solution of nitrate of silver, directly upon the glass, and of holding it there during all the manipulations necessary to the production of the finished negative, it was found necessary to incorporate the sensitive salts with other substances capable of giving the glass support a regular, continuous, and adhering surface.

Many important considerations govern the choice of these substances. They must be capable of liquefaction in order that they may be easily and quickly spread upon the glass or other support; they must have the property of setting, or hardening on the support; they must be or become insoluble in the successive baths through which they must be passed; they must be easily permeated by the various reagents to whose action they will be submitted, and they must have no injurious effect upon the sensitive salts.

The result of patient and laborious investigation long-continued has narrowed the list of suitable substances down to three: albumen, collodion, and gelatine, given here in the order of their introduction. Each of these has given its name to a group of processes, the best of which will be described in later chapters.

At this point it is sufficient to say that each of these substances has its merits and its defects. Albumen gives films to the finest grain, but of great tenuity. It must be coagulated by a strong nitrate bath, which lessens its permeability, and thus lengthens the time of exposure. Collodion films set very rapidly, owing to the evaporation of the solvents; they are easily permeated by the various photographic reagents; they are easy and economical of production, and while they do not always unite great sensitiveness with good keeping qualities, they unquestionably yield negatives of irreproachable printing qualities, superior in many respects to those produced on the modern gelatine plates.

The collodion process has too many points of excellence to be finally superseded by any rival methods, although at present it may seem to be in abeyance, owing to the great popularity enjoyed by gelatine emulsion plates. Gelatine gives quickly-setting, highly-sensitive films, which retain their good quali-

ties for an indefinite period, and which are easily acted upon by the reagents, and notwithstanding some drawbacks, gelatine has usurped the place once held by collodion in the photographic laboratory.

The Dark-room and Laboratory.—The convenience and comfort of the photographer will be greatly enhanced by the arrangement of the room or rooms in which his work is done. The dark-room in which the sensitive surfaces are prepared and developed may be of any size within reach of the operator; it must be lighted in such a way as to enable him to see what he is doing without the light exerting any injurious effect upon the preparations. Experiment has shown that the red end of the spectrum has least influence upon iodide and bromide of silver; therefore a light varying from orange to red or ruby is in common use.

It must be borne in mind that no light is absolutely non-actinic, that is, without reducing power on salts of silver; the only difference between rays of different colors being the length of time required to effect the reduction. The orange-red end of the spectrum being the slowest in its action, some one of these colors, or a combination of them, is used for dark-room illumination.

For albumen, collodion, and slow gelatine plates yellow light is safe; for highly sensitive gelatine plates a ruby or a greenish-yellow light must be used, and the plate exposed to its action as little as possible. For orthochromatic plates, which are made highly sensitive to the yellow and red rays, the smallest possible amount of illumination is necessary, and the plates must be most carefully guarded from the direct rays. Schuman, Eder, and others use a screen made of three thicknesses of brown tissue-paper. This gives a pleasant and safe light, which is especially recommended for color-sensitive or orthochromatic plates.

The source of light may be gas, oil, electricity, or the sun, according to the taste of the operator; it may be inside or outside the dark-room, as preferred. My own preference is for an oil or gas light outside the rooms. An opening of convenient size, shape, and position is cut in one of the walls of the

dark-room; this is provided with sliding frames carrying respectively a ground glass, a yellow, a green, and a ruby glass; a curtain is arranged to slide back and forth behind these frames, and a shade is hinged to the wall above. This combination of arrangements seems to give all the necessary modifications, and the changes are quickly and easily made.

The size and internal fittings of the dark-room will vary to suit the convenience of the operator, and the amount and kind of work to be done in it. If the room is used only for development it need not be larger than six by eight feet. If it is to be used as well for the preparation of plates it must necessarily be larger; nine by twelve feet will be a convenient size for a room of this description.

For the guidance of those who may wish to fit up such a room the following diagram and description is given:

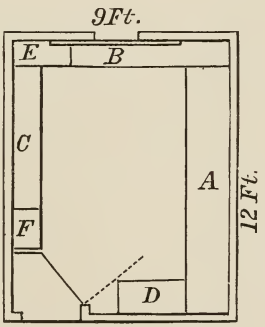

FIG. 1.

A, is a broad shelf at which the coating of the plates is done. On it is the levelled slab used to hasten the setting of gelatine plates, and above are shelves containing the various chemicals, vessels, and utensils used in the preparation of the sensitive compounds. B, immediately facing the window, is the developing shelf. It inclines slightly toward the sink E, and is covered with sheet lead. Above it on suitable shelves are stored the developing solutions and chemicals. The space underneath is divided into vertical compartments to hold the

various sized trays used for development. C, is a shelf running across the room. The end nearest the sink is used for fixing, and here are kept all fixing solutions and trays. D, is the drying-box, and F, is a light-tight closet for the storage of plates, sensitive paper, etc.

The double door arrangement shown in the cut is a great convenience, allowing ingress or egress without the necessity of covering the plates to prevent them from being light-struck.

The open space in the middle of the room is large enough to be utilized for enlarging purposes. The wall space above and below the shelves shown in the cut may be fitted up to suit special needs. The room is ventilated by boring holes at the top and bottom of one side and covering them in such a way as to prevent the ingress of light. The method shown in the cut below is simple and effective.

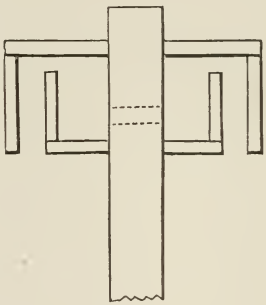

Fig. 2.

Cleanliness will be greatly promoted by covering the floor with oil cloth; this is easily cleaned and can be renewed when worn out.

Such a room as this would seem to meet all the requirements of the professional or amateur photographer, especially if a good supply of running water can be laid on. In default of this, a large tank can be fastened to the wall above the sink and fitted with a tap.

The Drying-Box. — Many photographic processes, both negative and positive, require a place in which the sensitive

surfaces can be dried by heat or otherwise, and in which they can be protected from light and dust.

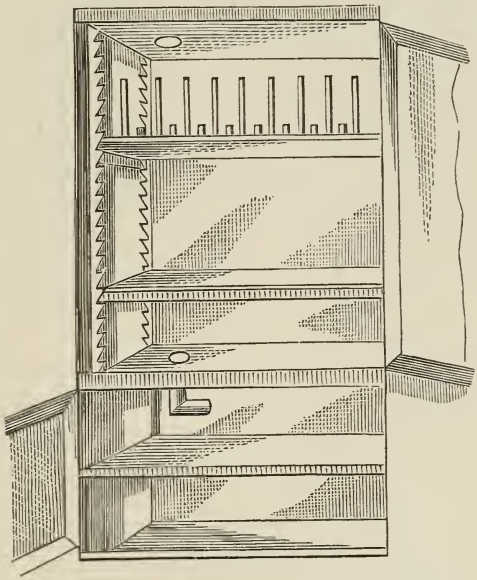

FIG. 3.

The drying-box shown in Fig. 3 will answer all these needs, and it is easy of construction and effective in operation. It may be placed in the dark-room, if the coating is done there, or elsewhere, to suit the convenience of the workman.

It is impossible to give any very definite dimensions, as these vary according to individual needs. A convenient size for the amateur workman is three feet high, two feet wide, and one foot deep from back to front. The box is divided into two unequal sized compartments, each closed by a door fitted light-tight. The upper portion, which occupies about three-fourths of the box, is the drying space proper, and is fitted as shown with notched side pieces to allow easy displacement of the shelves. The bottom is a moderately thick piece of sheet iron, accurately and tightly fitted to the sides of the box, to prevent the escape of gas into the drying chamber. In

one corner of this plate a hole is cut to take the ventilating-pipe, which passes through the back and is there again bent at right angles. A second pipe, also bent, leading from the top of the box, serves in connection with the first to establish a current of air. If it is necessary to dry the sensitive surfaces by hot air, the source of heat is placed in the lower compartment, immediately under the iron plate. If a current of cold air is desired, a lamp or gas jet is placed in the upper pipe. When not in use as a drying-box, it can be used for other purposes. Wood may be used in its construction in place of metal, but the danger of fire is increased.

This is the box recommended by M. Davanne, who also gives the following method for drying the plates vertically.

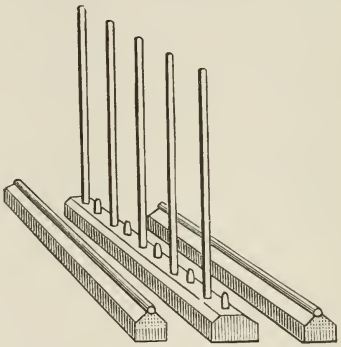

Fig. 4.

As shown by the cut, Fig. 4, the racking arrangement consists of three bars of wood placed side by side on the movable ledges of the drying-box. The middle bar, which is one-quarter of an inch thinner than the two side bars, is provided with a series of vertical rods placed about four inches apart; they are about six inches high, and of sufficient size to prevent bending or shaking. Between these bars pieces of glass rods, one-half an inch high, are fixed. With this arrangement two plates can be placed between the rods. If it is preferred, the glass rods can be dispensed with, and the wooden uprights brought nearer together, but one plate can then be placed against each upright. The side bars are one-quarter of an inch higher than the middle one. Their two upper surfaces are

beveled off, and glass rods are fitted into grooves cut in the tops of each. The plates rest on these rods, which are easily cleaned after each operation of drying.

When paper coated with emulsion is to be dried in this box, it is only necessary to remove the middle bar, and to pin the paper to the two side bars.

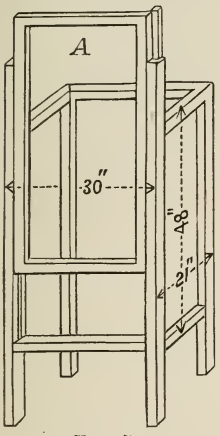

FIG. 5.

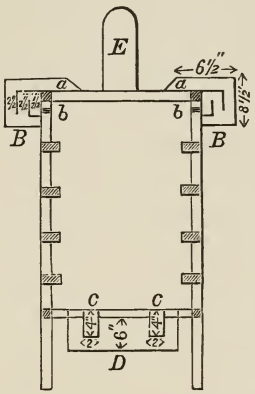

FIG. 6.

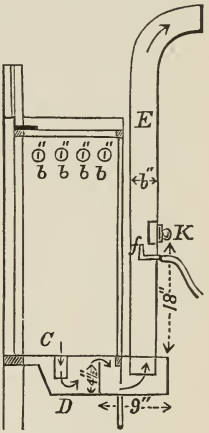

FIG. 7.

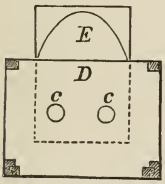

FIG. 8.

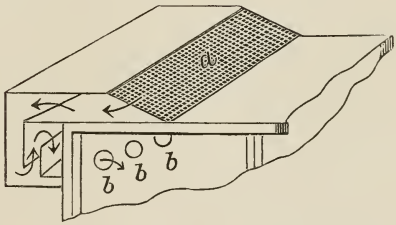

FIG. 9.

Figures 5, 6, 7, 8, and 9, illustrate the details of the construction of a more elaborate drying-box, of German origin, I believe. Fig. 5, is a general plan of the framework, showing the sliding door. Fig. 6, shows the ventilating arrangements from the front; Fig. 7, is a side view; Fig. 8, the bottom plan, and Fig. 9 the cut-off for excluding light from the interior. Dust is excluded by a strip of muslin glued over the opening of the cut-off.

D, Figures 6, 7, and 8, is a sheet-iron box, six inches deep, fastened to the bottom of the drying-box, projecting far

enough beyond the back, to allow the insertion of the six-inch pipe, E, Figures 6, 7, and 8. On the inside are riveted two pieces of sheet iron, four and one-half inches wide, and passing completely across. C, C, Figures 6, 7, and 8, are pieces of two-inch iron pipe, four inches long, projecting into the box, D, and opening into the drying chamber, F. Figure 7, is a gas jet, which, burning inside the pipe, E, produces the current. K, Figure 7, is a door in the pipe, which allows the height of the flame to be seen. In default of gas, an oil lamp can be used, supporting it on angle-irons riveted inside the pipe. The shelving arrangements can be made to suit the fancy of the operator. The framework is of wood, the sides may be of wood, sheet iron, or zinc, as desired.

If the coating-room is dry, well ventilated, free from dust, and light-tight, the plates may be racked away on shelves placed near the top of the room to dry spontaneously. This is my own practice, and I prefer it to the most elaborate drying-boxes, which do not always dry well.

Utensils.—It is manifestly impossible to give a complete inventory of all the various glasses, graduates, and other paraphernalia which accumulate in and about the photographic work-shop. Some pride themselves on doing all their work with the fewest possible conveniences; while others must have an infinite number of belongings before setting to work. The list which is here given is intended to cover everything really needed in the performance of all the processes included in these pages. If the list seems a long one it must be remembered that the number of negative processes is large, and that all of them have special requirements in the way of apparatus.

For development a number of flat trays of different sizes will be needed. These may be of glass, porcelain, gutta percha, japanned iron, wood, or even pasteboard in an emergency. Glass and porcelain are the cleanliest, and must have the preference for regular work in the dark-room.

For the chemicals nothing can be better than the wide-mouthed glass-stoppered bottles used by druggists.

For mixing solutions the cylindrical glasses known as beak-

ers are well adapted, and a number of these of different capacities should be provided, together with a goodly number of glass stirring-rods. Graduates of different sizes are a necessity; test tubes, pipettes, porcelain capsules for heating liquids, a glass mortar and pestle, specific gravity glasses for determining the specific gravity of liquids, glass funnels of various sizes, Bohemian glasses of various shapes and sizes for emulsion making, a retort stand, a Bunsen gas burner, or a Liebig spirit lamp, a retort or two, a hot-water bath, two or three drying racks, a washing box, a distilling arrangement, and an apparatus for hot filtration will well stock the photographic laboratory. Not all of them need be kept in the dark-room. Most of them should be kept in a room set apart for such operations as do not shun the light of day; a working laboratory in fact, which may be fitted up to suit the inclination and purse of the experimenter. It should have a sink, an abundant supply of water, a strong work table, with a stone or marble top, and a draining rack where the various glass bottles, etc., may be put

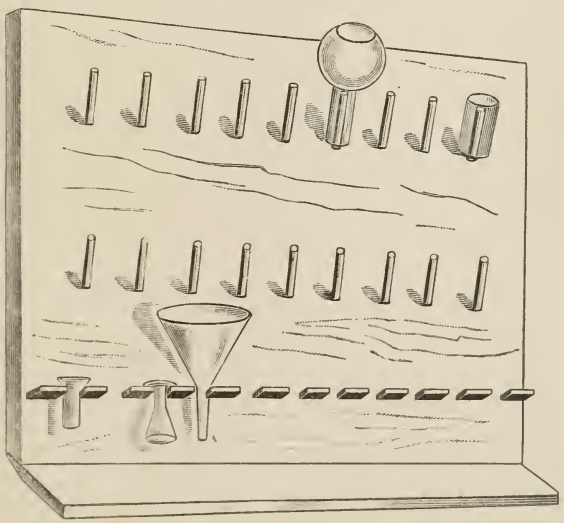

Fig. 10.

to drain and dry after washing. Such a rack is shown in Fig. 10, and its use is sufficiently apparent to need no further description.

Solutions.—The photographer uses all his chemicals in the form of solutions. The most common method of making a solution is to weigh out the proper amount of the chemical required, throw it into the bottom of a bottle, add the proper quantity of water, and then leave it to take care of itself. This is the simplest method and the poorest. It produces a local saturation of the lower portion of the liquid, and in a short time the process of solution ceases entirely. A better way is to pulverize the chemical before adding the water, and to assist the solvent action by frequent stirrings. The best way is to keep the chemical near the surface of the liquid, or even above it. This hastens solution, because the liquid in contact with the chemical is continually being replaced as the heavier saturated portion falls to the bottom. Two methods may be adopted to effect this result; one is to pour the liquid into a wide-mouthed bottle and to suspend the chemical in a bag, so that it is just covered; another way, and the more scientific, is shown in Fig. 11. A gutta-percha tube fitting tightly into the mouth of a flask is forced tightly over the tube of a funnel to produce an air-tight joint. Two-thirds of the liquid is poured into the flask, the remaining third and the chemical to be dissolved are placed in the funnel and the mouth of the flask is hermetically sealed by forcing the rubber tube into it. The lower end of the tube must be below the surface of the liquid. As the air cannot escape, and the heavier saturated liquid must descend, two currents are soon established in the tube, one descending, bearing the saturated liquid, the other ascending, bearing fresh portions. The operation is automatic and speedy. If the filtered solution is wanted it is only necessary to place a filter paper in the funnel. A saturated solution is made by placing in the funnel an excess of the substance to be dissolved.

Fig. 11.

Filtration.—To produce clean work in photography all solutions must be filtered. The means of doing this with or-

dinary aqueous solutions are too well known to need description. Solutions containing gelatine, gum, and similar substances, as a rule need to be kept warm during filtration to prevent them from cooling down and filling the pores of the paper. Two very effective systems of warm filtration are shown in Figs. 12 and 13. In both the inner glass funnel is tightly fitted to the outer one of tin by means of a pierced cork. Warm water is poured into the outer funnel and its temperature maintained by a spirit, gas, or oil lamp.

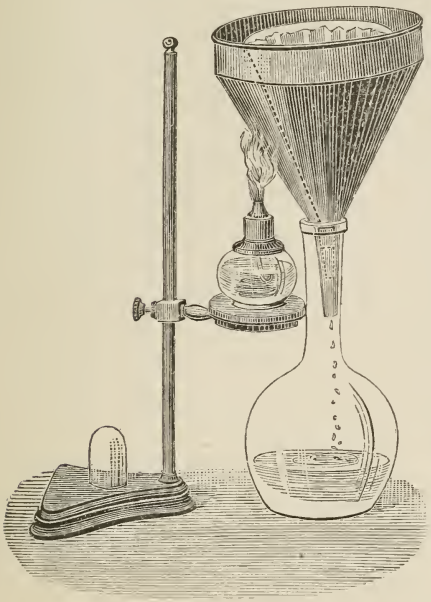

Fig 12.

Upward filtration will be found a valuable method for filtering emulsions of any kind, as bubbles are entirely prevented. One or more thicknesses of muslin, according to its fineness, are tied over the mouth of a beaker or other glass, the bottom of which has been removed. The emulsion is placed in a vessel a trifle larger than the filter, which is allowed to sink by its own weight. When full it is withdrawn and the emul-

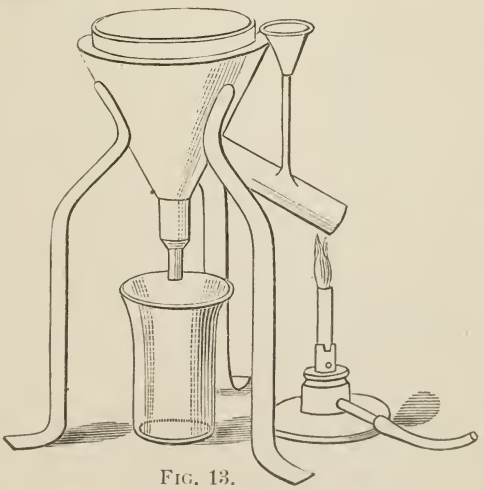

Fig. 13.

sion poured out. The dish containing the emulsion should be placed in a hot water bath.

In case of need the ordinary filter paper may be replaced with glass, as in the case of strong acid or alkaline solutions, which might attack the paper, or with filtering cotton, or a piece of chamois skin previously well soaked in a sal soda solution and well washed for collodion or gelatine emulsion. Flaxen tow is also sometimes used for this purpose.

Precipitation.—The term precipitates is applied to the insoluble substances which are formed in a solution, when by a change in the nature of the substance held in solution or in the solvent, insoluble and non-crystalline bodies are formed. Precipitation is resorted to to obtain certain substances or fluids difficult or impossible to be had in any other way. The liquid and the precipitate are first separated by filtration, and then the precipitate, if wanted, is freed from impurities by washing.

Washing Precipitates.—Precipitates are commonly washed on filter paper, small quantities of water being poured into the filter until the drainings when treated with the proper reagents,show no traces of the dissolved substances from which the precipitate has been formed.

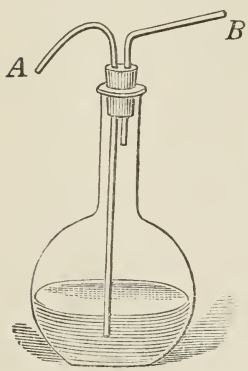

Fig. 14.

Another method is to use the washing bottle of the chemist, shown in Fig. 14.

A, and B, are two glass tubes bent as shown, and tightly fitted into the cork which closes the mouth of the bottle. The precipitate is placed in the bottle, which is then partly filled with water; the cork is then inserted, and by blowing through B, a stream of water is forced through A, the upper end of which is drawn out somewhat to diminish the size of the bore.

Decantation.—When the precipitates are coarse grained and heavy they may be easily and quickly washed by decantation. The precipitate is placed in a large beaker or tumbler, which is then filled with water, and the contents well stirred with a glass rod. As soon as the precipitate has fallen to the

bottom the water is carefully poured off as closely as possible. This operation is repeated ten or more times, and the precipitate is then thrown on a filter and allowed to drain.

The use of a decantation flask will greatly facilitate the operation. This is a flask provided with two tubes, a large and a small one. A piece of fine muslin is tied over the mouth of the smaller tube, the water and the precipitate are introduced through the larger. The water is poured away through the smaller tube.

Distilling Apparatus.—Many photographic operations require distilled water to secure the best results; it would be well to use nothing else in making up solutions. The use of distilled water would probably be more general were it not for the high price and great bulk of the ordinary worm still. Fig. 15 illustrates a simple form of a portable still which is open to neither of these objections. It can be easily and cheaply constructed by any tinman; it is effective in operation and easily kept clean. The dimensions given below will give a still capable of distilling a gallon of water at a time. It is made of stout tin or copper, as preferred. The cylindrical

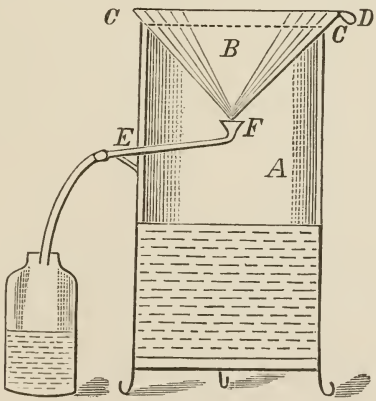

Fig. 15.

body, A, is thirteen inches high and seven inches in diameter. The funnel-shaped lid, B, is eight and a half inches in diameter and five inches in height from base to apex. It is provided with a flange, C, C, to fit accurately inside the cylinder

like an ordinary pail cover, and a tube, D, a couple of inches long, near the top of the cone. About five inches from the top of the body a tube, E, about ten inches long, is passed through, terminating at the inside in a small funnel, F, exactly under the tip of the cone. The other end projects about three inches at the outside of the cylinder. The three legs, made of strap iron, are riveted to the body, and may be of any convenient length.

Common tap water is poured into the cylinder, the cone lid is put in place, and the apparatus is placed over a gas or oil stove near the water supply. A gentle stream of running water is led into the cone by a piece of rubber tubing. The steam produced from the boiling water is condensed on the under side of the cone, and runs down into the funnel and tube, and is caught in a flask placed underneath the pipe. This still is the invention of Mr. C. C. Vevers, of England, the description being given nearly in his own words.

If running water cannot be had the cone can be occasionally replenished with cold water from a pail, or small lumps of ice can be thrown in now and then to keep the water cool.

CHAPTER II.

PRELIMINARY REMARKS ON EXPOSURE, DEVELOPMENT, FIXING, ETC.

It will serve to pave the way to the more practical discussion of the manipulations peculiar to the different negative processes if a few pages are devoted to the general principles common to all.

The production of a negative by any of the methods, described later, requires an exposure to light more or less prolonged, followed by development, fixing, washing, and in many cases a strengthening or weakening of the image produced by development. While each of these manipulations has special modifications to adapt it to the different processes, they all agree in certain broad and general principles, the knowledge of which is essential to that complete mastery of the subject without which the operator will be continually working in the dark.

These general principles will be discussed in this chapter, leaving their application to special cases to be explained later on.

Exposure.—Whenever a ray of light falls upon a sensitive surface a change of some kind is produced. Of the precise nature of this change we, at present, know but very little, and where little is known, little had best be said. We do know, however, that this change, invisible to the eye, can be made visible by the application of certain reagents to the exposed surface. The latent image then shows itself with a perfection and detail proportioned to the duration of the exposure and the strength of the reagent. The behavior of the exposed surface in the developer is to some extent a means of determining the correctness of the exposure. If the image appears suddenly in all its details and then as suddenly clouds over, we know

the exposure was too prolonged. If the image comes up slowly and is poor in detail, the exposure was not sufficient. In neither of these cases will a good negative be produced.

A good printing negative is one in which the high lights show points of opacity, and the deepest shadows almost bare glass, with an infinite gradation of tones between these two extremes. Such a negative is largely the product of correct exposure. Much may be done in development to make amends for a faulty exposure, but the best technical negative will always be the properly exposed and rightly developed one.

Beyond question the time of exposure is one of the most important of photographic manipulations, and even with a careful study of all the facts which determine its length, aided by much experience, it is only possible to acquire an approximately correct judgment.

Three different sets of facts must be considered in this connection; viz., the physical, chemical, and optical conditions present and influencing the duration of the exposure.

The physical conditions are such as the following: the nature, intensity, and color of the light, and the distance, color, and lighting of the object to be reproduced. These the view photographer has little or no power to change. He must take them as he finds them, and rely on his own judgment as to the time of exposure best suited to the view before him.

Despite many ingenious attempts, no mechanical means of settling the question have as yet been discovered of sufficient accuracy to take the place of long experience and good judgment. The simplest are based on the darkening action of light on sensitive paper confined in a box and exposed through a narrow slit cut in its cover. The best and most accurate require too much scientific knowledge to be generally useful, and none give anything more than a relative estimate of the intensity of the light.

The chemical conditions depend on the method employed in making the sensitive compound; sensitiveness increasing in the following order: albumen, calotype, collodio-albumen,

dry collodion, wet collodion, gelatino-bromide. The comparative rapidity of each is approximately given in the following table:

Albumen	10 to 30 minutes
Calotype	8 to 20 minutes
Collodio-Albumen	3 to 10 minutes
Dry Collodion	1 to 5 minutes
Wet Collodion	5 to 60 seconds
Gelatino-Bromide	1 to 10 seconds

These figures represent average results with emulsions or preparations of medium sensitiveness in each class.

The optical conditions influencing the exposure are the focal length of the objective, the size of the diaphragm, the number, thickness, and degree of coloration of the lenses, and the distance from the view.

These conditions are subject to one or more of the following laws:

1. The time of exposure varies directly as the focal lengths of the objectives.

2. The time of exposure is inversely proportioned to the squares of the diameters of the diaphragms.

3. The time of exposure varies inversely as the distances of the objects to be photographed. To this law is due the reproduction of the effect known as ærial perspective.

Development.—To the eye, and even to the microscope, an exposed plate shows nothing to distinguish it from an unexposed one. The developer alone detects the difference, without, however, conveying any information as to the nature of the change.

Notwithstanding much patient investigation the question of the nature of the latent image is still an unsettled one. The most commonly accepted theory is that a molecular change is produced by the action of light upon sensitive compounds, the molecules being pulled apart, as it were, and so made less stable.

This molecular change is not supposed to produce any separation of elements, such as occurs when a visible image is formed by the action of light.

The function of a developer is to make this change visible by reducing the silver in those parts acted upon by light to the metallic state.

It has long been a disputed question among photographic savants whether the change produced in a sensitive compound of silver is a physical or a chemical change. Without burdening the reader with the arguments advanced in support of each of these positions, it may be stated that at present the weight of authority seems to be on the side of a chemical change.

It may be regarded as a tolerably certain fact that under the action of light the haloid salts of silver, that is, the bromide, iodide and chloride, have a tendency, more or less powerful, to return to the metallic state; a tendency which is promoted and made permanent by the action of developers, which are always reducing agents; that is, they are substances which are able to reduce the soluble salts of silver to the metallic state. We may thus take it for granted, for the present at least, that the change of condition produced in the sensitive compounds employed for the production of negatives is a chemical, not a physical reaction.

The development of negatives may be effected in one of two ways:

1st Method.—The new compound may possess an attractive force. The action of light on sensitive compounds of silver tends to cause the formation of a substance capable of attracting the metal of which it is a salt, when slowly deposited from a solution. This first deposit is capable of attracting more of the metal, and in this way an image is gradually built up. This is the theory of the physical development of wet collodion plates.

2d Method.—The image may be the result of the reduction, more or less complete, to a more elementary state, of the altered compound when treated with certain solutions; in which state it may have the same attractive power as before. This is the rationale of all alkaline development.

The proper development of a negative is an art acquired only after long experience and many failures. It cannot be

learned from books; it must be acquired at the developing table. The problem to be solved is to bring forth on the exposed surface a reproduction of the original which shall preserve all the varied tones, and be capable of reproducing in the print the impression made by the original.

As a first step towards the solution of this problem it is best to begin with a weak developer, strengthening it as need arises. This gives more control of the reducing action by which the image is built up, and gives the operator time to see and meet the needs of each case. This method is particularly desirable with instantaneous exposures. Here a strong developer would probably ruin the plate, burying the high lights beneath an opaque deposit of metallic silver long before any detail was visible in the shadows. It is always best to make sure of the details before securing density. The latter is always possible at any stage of development, while if the proper degree of density is reached before the details are well out, the plate will be lacking in that exquisite gradation of tone which makes the charm of a perfect negative.

The common practice is to keep the developer in constant motion, in order to renew the portion in contact with the plate, and so secure uniformity of action.

Many operators, however, claim that finer details are secured by allowing the plate to remain undisturbed. In the case of pyro development there is less danger of the film becoming stained by the oxidization of the pyro.

When prolonged development is necessary, it is best to turn the plate face down in the developer, supporting it by the extreme edges in such a way as to leave a fair depth of the solution between the plate and the bottom of the tray.

When the development is very rapid, as with wet collodion plates developed with protosulphate of iron, the plate is to be held in the hand and as much developer as the plate will hold poured on and allowed to act until the process of development is completed.

If the latent image flashes up at once under the action of the developer, the exposure was too great. If, however, the high-lights only appear, the half-tones hanging back, the ex-

posure was too short. Both of these errors can be corrected, to a certain extent, by certain modifications of the developer.

Development must be continued until the proper degree of density is reached, generally until the image is faintly visible at the back of the plate. Viewed by transmitted light the highest lights should be nearly opaque, and the gradations between the shadows, the half-tones, and the high-lights should be well marked and distinct.

After development, the plate is washed in several changes of water and then fixed.

Fixing.—The office of the fixing-bath is to dissolve out all the silver salts not converted to the metallic state by the developer. If this were not done, and the unfixed plate were exposed to the action of light, the surface of the plate would assume a uniformly dark tint and the image would be lost.

There are many substances which possess this power of dissolving the salts of silver, but only three of them are of use in photography; these are the alkaline sulphocyanides (potassium or ammonium), the cyanide of potassium and the thiosulphate of soda, commonly known as hyposulphite of sodium. The chemical action of all these compounds is practically the same. In conjunction with the salts of silver they form respectively the sulphocyanide, the cyanide, and the hyposulphite of silver, all of which are insoluble in water, but soluble in an excess of alkaline sulphocyanide, cyanide, or hyposulphite. Hence the necessity of employing an excess of the fixing agent.

The sulphocyanide and the cyanide fixing-baths are but little used; the former on account of its cost, the latter because of its exceedingly poisonous nature.

Hyposulphite of soda is cheap, harmless, and effective; its sole drawback being the difficulty of eliminating it entirely from the negative, without which perfect elimination the keeping qualities of the negative are greatly lessened.

The effect of the fixing-bath is to deprive the negative of its milky appearance due to the unreduced silver. This it does by dissolving the unreduced salts, but in so doing the exceedingly unstable compound known as hyposulphite of silver

is formed. This is a white substance which rapidly decomposes into black sulphide of silver. The decomposition does not take place in an excess of hyposulphite of soda; in this case double salts are formed and rapidly dissolved. The quantity of the hypo must then be in excess of the amount actually required to dissolve the unreduced salt.

The fixing action is commonly supposed to be complete when the negative has lost its milky appearance. Portions of the double salts may still be undissolved, however, and it is best to allow the fixing agent to act for a few moments after the milky appearance has disappeared. The negative is then ready for washing.

Washing.—Hyposulphite of soda has a strong inclination to remain in the pores of the film, especially gelatine films. These require a thorough washing and a subsequent treatment with some hypo eliminator to eliminate the last traces of the salt.

The negative may be washed in ordinary trays in running water, or by frequently changing it, but this method requires longer washing, as the negative lies in the bottom of the tray with its face up, upon which the heavy hypo-charged liquid rests. Another method is to place the negatives in washing boxes provided with grooves, and then wash in running water. The most effective method is to place the negatives film side down in a triangular box provided with a stop cock at one end, and to wash in running water or with frequent changes. The hypo as it leaves the film falls to the bottom of the tray and is drawn off through the stop cock. Negatives washed for twenty minutes in running water in this box show no traces of hypo even to the most delicate tests.

Whatever method of washing is adopted it is always safe to test for hypo, which may be done in several ways, as shown later on. After sufficient washing, the negatives, if on gelatine films, may be soaked for a short time in a strong alum bath to harden the film. They are then washed a few moments longer, and after the faces have been brushed over with a broad camel's-hair brush to remove all adhering particles, they are racked away to dry in a place free from dust.

When dry, proofs are taken to determine if the negative needs any further treatment in the way of strengthening, reducing, or local touching up before being varnished.

Intensification.—It often happens that the negative through over-exposure or under-development lacks sufficient density to give good prints. In such cases it must be strengthened or intensified. This is done by causing the negative to take a deposit of some chemical substance in order to produce greater thickness of the lines. Intensifiers differ according to the nature of the sensitive surface. With albumen and collodion the most common intensifier consists of a mixture of gallic and pyrogallic acids and nitrate of silver strongly acidified with acetic acid. For gelatine films most operators employ a saturated solution of bichloride of mercury; this forms the chloride of silver and the insoluble proto-chloride of mercury which is deposited on the film, causing it to assume a creamy tint, which is changed to a brown or black by subsequent treatment with a solution of ammonia or sulphite of soda. Specific instructions for the use of these and other intensifiers will be found under the various processes described.

Reduction.—Over-development is apt to produce hard negatives incapable of yielding prints full of soft and delicate gradations. Such negatives may often be made fit for use by reducing the excessive thickness of the deposit of metallic silver. This may be effected by treating the negative with solutions of iodide, cyanide, or the perchlorides. These change the deposit on the film into the iodide, cyanide, or chloride of silver, which are then dissolved in a cyanide or hypo bath.

Success in this treatment is by no means certain, owing to the impossibility of knowing to what extent the metallic silver has been converted to the soluble salt until the negative is taken from the fixing-bath. Reduction, therefore, is to be resorted to only in extreme cases. Other methods will be found in Chapter XI.

Varnishing.—Collodion negatives must, albumen and gelatine negatives should, be protected from chance of injury by flowing over the films a thin coat of varnish. If the negative does not require touching up, any good negative varnish will

answer. The following is as good as any and is easily made: Dissolve pure yellow lac in alcohol in the proportions of 150 grains of lac to three and a half ounces of alcohol, sp. gr. .83. Some days are required to effect solution, during which the flask is occasionally shaken. The varnish is then well filtered, and is applied to the plate, previously slightly warmed, by pouring it upon the plate held in a horizontal position. When the plate is well covered the surplus is poured off, and the varnish dried by gentle heat, the plate being rocked to prevent the formation of ridges.

A good retouching varnish is made as follows:

Sandarac	1 ounce
Castor oil	1 dram
Alcohol	6 ounces

The sandarac is first dissolved in the alcohol, after which the oil is added.

CHAPTER III.

CALOTYPE.

This is the name which Fox Talbot gave to the process by which he obtained the first negatives ever made. In this process, paper of a fine and even texture, as free from grain as possible, is immersed in a bath containing an iodide, and when wanted for use is sensitized on a bath of nitrate of silver, and then exposed.

Plain Saxe or Rives paper is immersed in a dilute solution of hydrochloric acid, the acid removed by thorough washing, and the sheets hung up to dry. As soon as dry they are ready to be treated with the silver iodide bath, made as follows:

No. 1. Silver nitrate	46 grains
Distilled water	6 drams
No. 2. Potassium iodide	46 grains
Distilled water	6 drams

The silver iodide is formed by pouring No. 2 into No. 1, with constant stirring. The iodide falls to the bottom of the beaker as a precipitate, which is allowed to settle; the water is then poured off as closely as possible, and the beaker again filled and the precipitate well stirred. The operation is repeated three or four times to eliminate the bye-product, potassium nitrate, which is not wanted.

The precipitate is then dissolved in the following potassium iodide solution:

Potassium iodide	462 grains
Water	$2\frac{1}{8}$ ounces

This is poured over the precipitate and well stirred. To insure complete solution, crystals of the potassium salt are added with constant stirring until the solution turns milky.

The solution is applied to the paper with a Buckle's brush, made by inclosing a thin tuft of cotton in the loop of a doubled string passed through a bore of a piece of glass tubing six or seven inches long. The loop being pulled up into the tube, a brush of cotton wool is formed.

The paper is cut to the proper size and pinned to a flat board, and the solution is brushed over its surface, brushing up and down and across, to secure an even coating. As soon as surface-dry the paper is immersed in a dish of distilled water, and after a two-minutes soaking is removed to a second dish, and then to a third; care must be taken to remove all air bells. After two or three hours soaking the potassium iodide will be removed. The paper is then hung up to dry, after which it may be preserved in any convenient way for future use, but as it is somewhat sensitive to light, it is best to store it in a dark, dry place.

When the paper is wanted for use it is sensitized by brushing over it, first pinning it to the board as before, a mixture of the following solutions:

No. 1. Silver nitrate..... 77 grains
Glacial acetic acid.....2½ drams
Water..... 14 drams
No. 2. Saturated solution of gallic acid in distilled water

To every dram of No. 1, add 60 drams of distilled water, then 1 dram of No. 2, and finally 30 drams of distilled water. In warm weather the proportion of water may be still further increased to prevent the speedy reduction of silver nitrate, owing to the presence of gallic acid. The mixture is well stirred and applied plentifully to the surface of the paper. All excess of moisture is then blotted off on pure filter paper. The paper is most sensitive while moist, but it will give images when dry, until the surface of the paper becomes discolored owing to the reduction of gallate of silver.

For exposure the paper may be placed between two pieces of glass and inserted in the holder, or if preferred it may be gummed by the corners to a glass plate or piece of thick pasteboard. The time of exposure is long, varying from five to twenty minutes. The sensitiveness may be increased by

increasing the proportions of the silver and gallic acid in the sensitizing mixture, but the keeping qualities of the prepared sheets diminish as their sensitiveness increases. It has been noticed that for brilliantly lighted subjects a highly sensitive condition gives the best results, while poorly lighted subjects require a paper of low sensitiveness to avoid fog.

Development is effected by pinning the exposed sheets to a board and applying the sensitizing mixture given above with the brush. As soon as the development seems to flag, the gallic acid solution No 2 is applied sparingly until the shadows begin to grow dim.

Under-exposed pictures require more of No. 1. If the image is fairly visible before development the paper was over exposed; in this case more of No. 2 should be added.

The negative is fixed in

Sodium hyposulphite	15 drams
Water	35 ounces

Fixing is complete when the yellowness of the iodide is no longer visible by transmitted light. A thorough washing for three or four hours in many changes of water is necessary to eliminate the hypo. When dry the negative can be printed from as it is, but the quality of the prints will be greatly improved by waxing the negative. This is readily done by heating a flat-iron hot enough to melt white wax, a cake of which substance is applied to the iron as it passes over the surface of the paper. As soon as the negative is evenly translucent, a sheet of blotting-paper is laid down upon it and the iron again applied to remove all superfluous wax. Care must be taken not to have the iron too hot, or the blotting-paper will absorb too much of the wax and cause the grain of the paper to become visible.

The above is a description of the method by which Fox Talbot obtained his first negatives, and it is given more as a matter of historical interest than because of its practical value. The great disadvantage of this and other like methods was the rapid deterioration of the sensitized sheets, owing to the combination of the silver nitrate with the vegetable fibres and the sizing of the papers, and also to the formation of a very fugitive compound of iodo-nitrate of silver.

Le Gray, in his once famous process, by waxing the paper before sensitizing, and by washing away all excess of nitrate, greatly increased the keeping qualities of the paper but diminished its sensitiveness, and M. Pelegry, a French amateur who has given much attention to the process, has of late years still further increased the keeping qualities of the paper and has also materially decreased the time of exposure.

Le Gray's Process.

Waxing.—A piece of thick sheet-iron is placed over an oil or gas stove and heated up to the melting point of wax. One or two sheets of blotting-paper are then placed on the iron, and upon these a sheet of the paper to be waxed. This is evenly waxed by rubbing it with a piece of white wax. A second sheet is laid over the one already treated, and waxed as before. This operation is continued until a dozen sheets have been impregnated. The sheets are then separated and again placed on the hot iron plate, but with a sheet of unwaxed paper between each waxed sheet. The pile is next evenly pressed down with a pad of clean blotting-paper, being frequently turned over. This process remelts the wax and impregnates the unwaxed sheets. If now, on separating the sheets, any of them show unwaxed spots, they are to be rewaxed as before, one at a time.

The sheets are best dried by placing them separately between blotting-papers, or two unwaxed sheets, and placing them on the warm iron plate. All excess of wax is now easily removed by using the pad of blotting paper. Excessive heating of the plate must be avoided during this operation, as this will produce a grained appearance impossible to remove by rewaxing.

The iodide bath.—

Whey (serum)	35 ounces
Iodide of potassium	130 grains
Bromide of potassium	30 "
Milk sugar (crystals)	308 "

Note.—The whey or serum is produced by boiling 40 to 45 ounces of milk. As soon as the milk boils acetic acid is added drop by drop until the milk is coagulated. The liquid is then

filtered through a piece of linen and allowed to cool, when the white of an egg, beaten to a froth, is added. The mixture is again boiled to coagulate the albumen, which clarifies the serum. The liquid is ready for use as soon as filtered.

As this bath soon ferments, it must be used within two days of its preparation.

The bath is filtered into a deep porcelain tray, and a waxed sheet is first floated on it, avoiding air bubbles, and then completely immersed in it, all air bells being removed with a clean camel's hair brush or a glass triangle. This process is repeated until a sufficient quantity of paper has been immersed, great care being taken that no air bells are allowed to form between the sheets. After soaking for two hours the sheets are pinned up by one corner to dry. In this condition they will keep indefinitely.

Sensitizing.—The sheets are immersed one after the other in the following bath:

Distilled water	3½ ounces
Nitrate of silver	108 grains
Glacial acetic acid	125 to 150 grains

To this are added eight to ten drops of the iodide solution given above. The mixture is well stirred and filtered into a porcelain tray used only for this purpose. The iodized sheets are to be immersed in this bath as described for iodizing, avoiding air bells. The sheets must not be allowed to stick together, and each one is turned over with a pair of bone or glass pincers before another is introduced.

After three or four minutes immersion the sheets are removed one by one and passed successively through three or four baths of distilled water. They are then placed between sheets of strong, pure blotting-paper and all excess of moisture removed, after which they are dried under pressure between fresh blotters. The first and second wash waters should be renewed for every three or four sheets. The more thorough the washing the longer the sheets will keep, but the less their sensitiveness. In any event they will keep only two or three days.

The paper, after being iodized, usually loses somewhat of its waxed appearance, which can be restored by placing the sheets previous to sensitizing between blotters and smoothing with a warm iron.

Exposure.—The prepared sheets are made ready for exposure as in Talbot's process and the exposure varies from ten to twenty minutes, according to circumstances.

Development and Fixing.—These operations are the same as in Talbot's method, except that the waxed paper is immersed in the developer.

Pelegry's Process.—This method is superior to the foregoing in the superior keeping qualities which it confers upon the sensitized sheets and in its greater sensitiveness.

Plain Saxe paper is immersed for a few moments in the iodide bath given in Le Gray's method, and hung up by one corner to dry.

When wanted for use the dried sheets are sensitized by a three minutes immersion in the following bath:

Distilled water	3½ ounces
Nitrate of silver	154 grains
Citric acid	10 grains

The sheets are immersed in the bath as in Le Gray's process, but no more than five sheets must be sensitized at the same time.

After remaining in the bath the requisite length of time, the sheets are removed one by one, allowed to drain slightly, and placed in a tray containing distilled water. Five more sheets are then sensitized and placed with the others. After a short soaking, during which the tray is rocked, the water is poured away, and a fresh supply added. The tray is again rocked for a few moments and the sheets are next placed in a tray containing a filtered solution of chloride of sodium, one to one hundred, to destroy the last traces of nitrate of silver.

After a short sojourn in this bath they are well washed in several changes of water, and finally immersed for two minutes in a tannin bath made as follows:

Two hundred and thirty grains of dextrine are macerated in a mortar with a little water; when solution is complete the

bulk is made up to twelve ounces of water, and the solution filtered. To this is added a filtered solution of two hundred and thirty grains of tannin in twelve ounces of water, and finally forty-five grains of gallic acid previously dissolved in four drams of alcohol.

After treatment with this preservative the paper is hung up to dry.

Paper prepared as above and preserved in a dark dry place will keep good from three to six months. The above formulæ will prepare 18 by 22 sheets of paper.

Exposure.—Well-lighted landscapes require from five to six minutes exposure. Sombre views will require at least thirty minutes for full exposure.

Development.—The development should, if possible, be effected within a few hours of exposure, but in case of necessity it may be deferred for some days.

The developer is thus compounded :

Water	3½ drams
Pyrogallic acid	15 grains
Citric acid	15 grains

The sheet to be developed is first moistened in a tray containing pure water and then immersed in the pyro solution, in which it is turned several times to insure equalization of the developer. The negative is then removed from the developer to which a dram or two of a three to one hundred solution of nitrate of silver is added; the tray is rocked to insure an equal mixture, and the negative is again placed in the solution. The image soon appears and development is arrested as soon as the details are well out and the density seems sufficient, the tray being well rocked. The negative is then washed in two changes of water and fixed in a one to six hyposulphite of soda solution, in which it is allowed to remain from thirty to forty minutes. It is then well washed and dried between blotting-papers. As soon as dry it is ready for oiling, which may be done as best suits the operator's taste and convenience, either with castor oil, translucine, vaseline, or wax.

CHAPTER IV.

SENSITIVE SURFACES ON GLASS. PREPARATION OF THE GLASS.

The glass plates should be selected with great care. They should be flat, and free from scratches and bubbles. For small sizes ordinary glass of good manufacture will answer, but for large pictures and process work, plate, or patent-plate, should be used. The rough edges should be smoothed down with a flat file, and the glasses should never be packed with pieces of printed paper between them, since printer's ink is apt to leave greasy spots on the plates, which must be perfectly clean before they are coated with the collodion or emulsion. New plates should be soaked for some hours in a solution of carbonate of soda, and then well washed and soaked for some time in a solution of equal parts of nitric acid and water. They are then well washed and dried, if not to be albumenized. Old collodion plates should be immersed over night in the following solution:

Sulphuric acid	1 ounce
Bichromate of potash	1 ounce
Water	16 ounces

and then washed.

This solution quickly destroys organic substances, but it must be renewed as soon as crystals are formed.

In all cases it is well to drain the plates on blotting paper, and to rub them dry with a piece of canton-flannel, which is used for no other purpose.

The Final Cleaning of the Glasses for the Albumen and Collodion Processes.—After the preliminary treatment with acid or bichromate of potash the dried plates are breathed on and rubbed with a clean towel kept for this purpose exclusively. It is important that the fingers do not touch the plate.

The towel is spread out on a clean table, the plate is laid upon it, and one end of the towel is folded over one edge of the plate, which is then rubbed with the other end of the towel.

After both sides and the edges of the plates have been thoroughly rubbed, it is tested by breathing upon it and examining it by reflected light. If it is perfectly clean the moisture of the breath will evaporate evenly. If, however, it shows spots it must be again breathed on and rubbed. If this fails to remove the spots, the plate must be returned to the acid bath. When the plate appears perfectly clean after this treatment, it is ready for the final polishing, which is done with chamois leather pads. The plate may be held in a cleaning vice or laid on a clean towel. A small quantity of alcohol is then poured on the plate and rubbed over it with one of the pads; the plate is next polished with another pad, and may be considered finished when it takes the breath evenly.

Instead of alcohol, old and worthless collodion is often used. Varnished plates must be soaked for some hours in a solution of soda; they are then washed with water, soaked in the acid bath, washed, and polished as above.

The towels and chamois skins used for cleaning and polishing must be washed in soda, never with soap.

Albumenizing the Glasses.—In order to avoid the tedious operation of polishing, many operators prefer to flow an albumen solution over the plate after it has been treated with the acid bath given above. The following solution is poured over the plate while still wet:

Whites of 2 eggs	
Water	64 ounces
Ammonia	1 dram
Iodide of potassium	½ dram

This is placed in a bottle containing glass broken up into small pieces and well shaken for fifteen minutes; it is then filtered and flowed over the glasses, the surplus being drained away to waste. The plates are racked away to dry in a room free from dust. They will keep for a month, and give as good results as those which have been polished.

Treatment of the Glasses for the Gelatine Emulsion Process.

The glass of old negatives which, for any cause, have become useless for printing, may be again coated after the films have been removed. The simplest method of removing old films is to soak the plates in a moderately strong solution of hydrochloric acid until the films are easily detached from the glasses, which after being well washed in clean warm water and rubbed with a coarse cloth to remove all adhering pieces of film, are ready for further treatment.

Cleaning the Glass.—Both old and new glass should be soaked in a ten per cent. solution of nitric acid, then well washed, and immersed in a solution of carbonate of soda containing a little alcohol. The plates while in this solution are well rubbed with a clean cloth, then washed in clean cold water until it flows evenly over them, rinsed in distilled water, and stood up to dry on blotting-paper. When dry they should be well wrapped up to prevent dust from settling on them.

Polishing with Talc.—When the films are to be stripped from the glass after fixing, the plates must be polished with French chalk. This is done by dusting a little of the chalk over them and polishing with a clean piece of linen, using a circular motion. All excess of chalk is dusted off with a camel's-hair brush. The plates are then flowed with plain collodion, and coated with the emulsion when the collodion is dry.

Substrata.—It is the practice of many coaters to give the plates a substratum of some kind to prevent blisters, or to assist the flowing of the emulsion. A few of the best of these substrata are here given.

1.—White of egg	1 ounce
Water	20 ounces
Alcohol	1 ounce
Carbolic acid	20 drops

Add the carbolic acid to the alcohol, and stir well; then pour the mixture into the albumen and water which have been previously mixed, then filter.

DR. VOGELS.

2.—*a*.—Gelatine ..... 150 grains
Acetic acid..... ½ ounce

Dissolve by heat.

b.—Chrome alum. ..... 10 grains
Water ..... ½ ounce

For use take of *a*, 2½ parts; *b*, 1 part; alcohol, 70 parts, and filter. Coat the plates as with collodion.

3.—Soluble water glass ..... 1 ounce
Albumen..... 8 ounces
Water..... 8 ounces

The wet plates are coated with this solution, drained, dried, and washed.

4.—Gelatine ..... 75 grains
Distilled water ..... 60 ounces
Ammonia ..... 2 drams
Alcohol..... 1 ounce

Soak the gelatine in half the given quantity of water, then add the remaining half at the boiling point; when cool add the ammonia and alcohol, and filter.

5.—White of egg..... 1 ounce
Water..... 100 ounces
Ammonia ..... 5 drops

Shake well for five miuutes, and then filter.

6.—India rubber ..... 10 grains
Water..... 1 ounce

Filter and flow over the plates like collodion.

More care must be taken in cleaning the plates when a substratum is to be used, the difficulty being to secure an even coating.

Instead of flowing the above solutions over the plates, they may be applied with a Blanchard brush, which is made by tieing a double thickness of fine canton-flannel, ribbed side out, over one end of a strip of glass about six inches long and two

inches wide. The brush is dipped in the solution and the excess squeezed out against the side of the beaker. The plate is then brushed smoothly down the surface in parallel lines. In this way a thin and even coating is applied.

CHAPTER V.

THE ALBUMEN PROCESS.

The second step in the development of the negative process was the employment of albumen as a vehicle for the suspension of the finely-divided sensitive salts, and, in consequence, the use of glass as the means of support. Niepce de Saint Victor seems to have been the first to work out a practical method for the use of albumen, and the process was greatly improved by later experimenters.

Although rarely used to-day, the process is a valuable one for delicate work, where the utmost possible fineness of grain is desired.

The drawbacks to the more general adoption of a process which undoubtedly yields the very finest photographic results, are, the long exposure necessary, the difficulty of securing an even coating of the extreme tenuity required to prevent the film from leaving the glass, and the extreme care demanded to prevent dust from settling on the films while drying. Methods of overcoming these difficulties will be given under the practical manipulations soon to be described.

The general outline of the process is as follows: The whites of several eggs are carefully separated from the yolks and germs, and beaten to a froth with a bundle of quill pens or a wooden fork. After standing for some hours, the deposit of albumen is decanted and filtered by upward filtration, as described on page 19.

An addition of an aqueous solution of iodide and bromide of potassium or ammonium is then made, and the mixture is well stirred and filtered as before. From this point on, the greatest precautions must be taken to prevent particles of dust from settling in the mixture.

The plates, which must be plate or patent plate, are next coated and dried in a perfectly horizontal position. In this condition, the plates are insensitive, and will keep for an indefinite period. They should be stored in a dust-proof box. When wanted for use, they are sensitized by an immersion in a nitrate of silver bath acidified with glacial acetic acid. The effect of this bath is to coagulate the albumen, to form the albuminate of silver, and to transform the soluble, insensitive iodide and bromide into the insoluble and sensitive iodide and bromide of silver. Therefore, the operation of sensitizing must be performed in yellow light.

After being sensitized, the plates are washed in many changes of pure filtered water, to remove all traces of nitrate of silver; they are then dried by heat and are ready to be exposed.

Gobert's Albumen Method.

Formulæ.

No. 1.—The Albumen Mixture.

Albumen from fresh eggs	26 drams
Iodide of ammonium	15 grains
Bromide of potassium	4 grains
Iodine in pellets	4 grains

First dissolve the salts in two ounces of water and then dissolve the iodine. Then add the solution to the albumen, beat to a froth, and, after standing for some hours, decant the albumen and filter twice, as described above.

No. 2.—The Sensitizing Bath.

Distilled water	4 ounces
Nitrate of silver	155 grains
Glacial acetic acid	2½ drams

Manipulations.

Cleaning the Glass.—Pour a few drops of hydrochloric acid on the surface of the glass plate, previously freed from all impurity by soaking first in a solution of caustic potash, then in dilute nitric acid, and well washed under the tap. Then polish

with a dabber of cotton dipped in the following iodine solution:

Iodine	4 grains
Alcohol	4 ounces

This is well rubbed in, and the plate dried with a piece of fine linen.

Coating.—A sufficient quantity of solution No. 1 is poured over the plate, which is held in the left hand by means of a pneumatic holder having a vertical handle provided with a small brass hook at the end. The albumen should be poured in a pool on the right-hand upper corner of the plate. When the surface of the plate is completely covered, to effect which some coaxing with a glass rod may be necessary, the excess is drained off in a reserve flask for filtration.

A pipette will be found very convenient for getting the albumen on the plate free from bubbles.

After draining as closely as possible, the plate is rocked gently to equalize the film. If any specks of dust or air bells are noticed, they must be removed with the point of a clean piece of paper, or with the pipette.

Notwithstanding the close draining, the film is still too thick; it must be made thinner, and at the same time equalized. This is done by suspending it, film down, by catching the hook in the handle in the loop of a doubled string hanging from the ceiling of the room. A slow rotary movement is then given to the plate. The centrifugal force thus generated throws off all excess of albumen, and equalizes the film except along the edges, where ridges are formed which are dried with blotting-paper when the plate is removed from the string.

In order to avoid spots of albumen on the floor and walls, it is best to suspend the plate in a large round metallic tray.

Drying the Plate.—The plate must be dried rapidly, and in a perfectly horizontal position. Perhaps the best method of combining these requisites, while at the same time reducing to a minimum the danger of dust falling on the film, is to place the plate film downwards on three levelling screws provided with needle points; these screws stand on an iron plate placed over an oil or gas stove.

The old daguerreotype gilding stand will be found a very convenient drying apparatus. If neither of these means are at hand, the plate may be dried by placing it on a warm iron plate film up, first putting two or three sheets of blotting-paper on the iron to equalize the heat.

Fuming with Vapors of Iodine.—The action of the sensitizing bath is greatly assisted by fuming the dried film with the vapors of iodine. The simplest way of doing this is to cut a rectangular opening, somewhat smaller than the plate, in the cover of a wooden box four or five inches in depth. Some pellets of iodine are placed in the bottom of the box, and the plate is laid over the opening in the cover film down, and fumed until it assumes a rich golden hue. It is then taken from the box, and after a short exposure to the atmosphere to allow the excess of iodine to volatilize, it is ready to be sensitized.

Sensitizing.—The plate is sensitized in yellow light by a three minute immersion in solution No. 2, above. It is then well washed in several changes of water, allowed to drain, and the preservative, a saturated solution of gallic acid, is flowed over it. It is then dried by gentle heat. The dried plates will retain their good qualities for some weeks. The films should have a decided opalescent appearance. If this is wanting, the film is too thin, owing to a too rapid rotation on the pneumatic holder. The remedy is obvious. The time of exposure varies from 10 to 30 minutes, according to circumstances.

Development.—The exposed plates are developed in a bath containing a saturated solution of gallic acid, to which has been added a few drops of a 1 to 30 solution of nitrate of silver.

The process should not be unduly hastened ; the best results are gained by slow development. The developer must be thrown away when it becomes cloudy.

The developer thus compounded will bring out all the details and give good printing density on properly exposed plates. If, however, the image shows a lack of detail and density after prolonged development, a fresh developer, containing gallic acid and silver, must be compounded.

Fixing.—After development the plate is rinsed in clean

water and immersed in a ten per cent. solution of hyposulphite of soda until the opalescent appearance has disappeared. It is then well washed in running water, to eliminate the hypo, and when dry it is ready to be printed from.

Various Modifications of the Albumen Process.

Numerous experiments have been made by different investigators to shorten the time of exposure by introducing various modifications, consisting chiefly in the use of a larger proportion of iodide and the addition of certain substances to produce a more porous, and, therefore, more sensitive film. A few of the best of these are here given.

Sella's Modification.—

Water	5 drams
White sugar	120 grains
Iodide of potassium	61 grains
Iodine in pellets	12 grains
Bromide of potassium	12 grains

Pour the solution into 14 ounces of albumen, beat to a froth, and, after standing for twenty-four hours, decant three-fourths of the liquid for use. The remaining manipulations are the same as described above.

Bagot's Modification.—

Dextrine	140 grains
Iodide of potassium	46 grains
Bromide of potassium	8 grains
Distilled water	11 drams

Dissolve by heat, filter and add the whites of six eggs. All the other operations are as described above, with the following exceptions: Sensitize on a ten per cent. solution of nitrate of silver, containing twenty-five per cent. of glacial acetic acid, and develop in the following bath:

Distilled water	12½ ounces
Gallic acid	108 grains
Acetate of lime	46 grains

at a temperature varying from 120 to 140 deg.

Couppier's Modification.—

Albumen	25 drams
Distilled water	6¼ drams
Iodide of potassium	15 grains

The manipulations are the same as in Gobert's method.

The Albumen Honey Process.—The following description of this process, as formerly worked by Whipple and Black, is taken from the *Photographic Times.* The plates are given a thin, even coating of the following solution:

Albumen	8 ounces
Honey	7 ounces

To which has been added

Iodide of potassium	3 grains
Bromide of potassium	20 grains
Chloride of sodium	10 grains
Water	2 ounces

The mixture is beaten to a stiff froth, allowed to settle, and then filtered.

The dried plates are sensitized, while still warm, in the following bath:

Nitrate of silver	1 ounce
Acetic acid, No. 8	8 to 10 drams
Water	10 ounces

The plate is kept in constant motion while in the bath. After sensitizing, the plates are washed slightly, if to be used immediately. If, however, they are to be kept for any length of time, they must be washed until all the silver is washed away. Development is effected in a saturated solution of gallic acid, to which a few drops of a nitrate of silver solution have been added.

CHAPTER VI.

THE COLLODION PROCESS, WET-PLATES.

Le Gray was the first to suggest collodion as a vehicle for the suspension of the salts of silver in place of the albumen method of St. Victor. To Scott Archer and Dr. Diamond, however, belong the credit of having been the first to introduce the collodion process in the practical form in which it is still used.

This was in 1851, and the publication of their process revolutionised photographic methods, and incited many experimenters to investigate the new process.

It would be impracticable to enter into a detailed discussion of the improvements discovered by such patient investigators as Martin, Gaudin, Spiller, Sutton, Schnauss, Carey Lea, Sdrouheim, Roettcher, Bellitzky, Vogel, Eder, Duchochois, and others, to all of whom photography is deeply indebted. The history of photography has been ably treated in another volume of this series, and need not be repeated here.

The advent of gelatine plates by no means sounded the death knell of collodion. It is still in common use by not a few of our best practitioners in all cases where the extreme of rapidity is not called for, and in the opinion of many good judges collodion negatives possess qualities which are only with extreme difficulty conferred upon gelatine plates.

For these reasons, the process is fully described in all its details, as practised by the best operators.

The base of collodion is the substance known as pyroxyline, or soluble gun-cotton, which is prepared by submitting cotton, paper, or other like substances, to the action of a mixture of sulphuric and nitric acids. The resulting substance, when dissolved in a mixture of ether and alcohol, forms the volatile, viscous compound known as collodion.

The preparation of pyroxyline suitable for photographic work is a somewhat delicate operation, and, as a rule, it is wise to purchase it ready-made of the dealer. The two formulæ for its manufacture which are given below, are recommended by Hardwich, who at one time made many experiments in this direction.

No. 1.

Sulphuric acid, sp. gr. 1.842 at 59 deg. F.	18	ounces
Nitric acid, sp. gr. 1.456	6	ounces
Water	4¾	ounces
Cotton wool	360	grains

No. 2.

Sulphuric acid, 1.842	6	ounces
Nitrate of potassium	3½	ounces
Cotton wool	62	ounces
Water	1	ounce

Mr. Abney says the cotton must be first well steeped in an aqueous solution of carbonate of soda, and then be well washed and perfectly dried. It should then be made up into ten or twelve balls.

The nitrate of potassium should be as free from chloride of potassium as possible, and dried in an air bath at a temperature of about 120 deg.

The water and nitric acid are poured into a porcelain dish and well mixed, then the sulphuric acid is added with constant stirring. The temperature will rise to about 170 deg., and the liquid must be allowed to cool down to about 150 deg. The balls of cotton are then immersed separately in the liquid, as rapidly as possible, to prevent decomposition. After receiving a thorough soaking, using a glass or porcelain spatula to keep the balls submerged, they are allowed to remain ten or fifteen minutes in the solution. They are then raised by the spatula, as much of the liquid as possible being extracted by pressing them against the side of the dish, and then they are placed in a large vessel full of clean water. The washing must be continued until a piece of blue litmus paper retains its color after two or three minutes' contact with the cotton, which, when dried, should weigh about 25 per cent. more than the original cotton.

It is important that the acids be of the specific gravity indicated in the formulæ, as any deviation will materially change the character of the pyroxyline. The second formula is usually to be preferred.

The Solvents.—Alcohol and ether in varying proportions are the solvents of pyroxyline employed in the manufacture of collodion. Many modifications may be made in the film by altering the proportions of the solvents. Up to a certain point an increase in the quantity of alcohol confers greater sensitiveness and density. It must not be too largely in excess, however, or tender, porous films will result.

An excess of ether gives strong, contractile films, which are easily stripped from the glass. The specific gravity of the alcohol must be varied to suit the sample of pyroxyline used in making up the collodion.

For pyroxyline prepared at a high temperature the alcohol should have a specific gravity of .812. For the tougher variety of pyroxyline a specific gravity of .820 is about right.

The ether should be as pure as possible.

The normal proportion of the solvents is equal volumes of each, but this may be modified as required.

The Iodizers.—These are the various metallic iodides and bromides which are added to the collodion to produce, when the plate is immersed in the silver bath, the sensitive iodide and bromide of silver. Obviously only those iodides and bromides can be used, which are soluble in alcohol and ether. Those most commonly employed are the iodides and bromides of potassium, ammonium, calcium, cadmium, sodium, and, more rarely, lithium.

These are not all of equal value for the preparation of the salted collodion. Three factors determine the choice of the soluble salt, viz., the physical action of the salts; the permanency of the resulting collodion, and the solubility of the salt.

Cadmium, although very soluble and giving a collodion of good keeping qualities, has a tendency to thicken the film, and must, therefore, be used with caution and only in connection with other salts.

The iodides of potassium and ammonium give more intense

images than the iodide of cadmium, but they are not so soluble and the resulting collodion does not keep so well.

The salts of sodium and lithium are but rarely used on account of their decomposing action.

A collodion containing iodide alone gives great density with little detail in the shadows, one containing bromide only gives less density but more detail in the shadows.

For this reason the common practice is to use mixed collodion for general work to secure both density and detail.

Plain Collodion.—It is customary to make up a stock of plain collodion to be iodized in sufficient quantity for the work in hand. This plain collodion can be kept indefinitely in well-stoppered bottles. The following formulæ are given for its preparation:

For Cold Weather.

Pyroxyline	185 to 215 grains
Alcohol	16 ounces
Ether	19 ounces

For Warm Weather.

Pyroxyline	185 to 215 grains
Alcohol	17½ ounces
Ether	17½ ounces

The quantity of pyroxyline may be increased if desired, but it should not exceed two per cent. An increase in pyroxyline increases the sensitiveness but diminishes the flowing quality of the collodion.

The usual method of making up the plain collodion is to add the pyroxyline to the alcohol and then to add the ether in small quantities, shaking well after each addition.

Some operators, however, prefer to add the pyroxyline to the ether, shaking it up well until the fibres are well distended, and then to add the alcohol in small quantities with constant shaking.

In either case the solution is allowed to stand for twenty-four hours before being used. Sufficient of the clear liquid for the work to be done is then decanted off.

Salted Collodion.—Plain collodion is iodized or salted by the addition of soluble iodides or bromides, or both.

The following formulæ will be found suitable for general landscapes, and portrait work:

BROMIZED COLLODION.

Bromide of zinc.....247 grains
Plain collodion .....35 ounces

IODIZED COLLODION.

a. Iodide of ammonium.....123 grains
Plain collodion.....35 ounces

b. Iodide of cadmium.....154 grains
Plain collodion.....35 ounces

a must be used at once; *b* will keep indefinitely.

BROMO-IODIZED COLLODION.

a. Iodide of ammonium.....108 grains
Bromide of cadmium.....62 grains
Plain collodion.....35 ounces

b. Iodide of cadmium.....139 grains
Bromide of cadmium.....62 grains
Plain collodion.....35 ounces

a can be used soon after making; *b* must be allowed to ripen for some time before it will flow well.

Another method of salting the collodion is to add to ninety parts of plain collodion, ten parts of the following bromo-iodide solution:

Absolute alcohol.....7¾ ounces
Iodide of cadmium.....154 grains
Bromide of cadmium.....154 grains
Iodide of ammonium.....154 grains

Mr. John Carbutt's Methods.—Mr. Carbutt first prepares the double salts of potassio-cadmium iodide and ammonio-cadmium bromide with which he prepares two collodions, which are mixed for use in varying proportions.

The potassio-cadmium iodide is made as follows: 332 parts of iodide of potassium and 366 parts of iodide of cadmium are dissolved in the smallest possible quantity of distilled water, and evaporated to dryness by gentle heat, and bottled for use.

The ammonio-cadmium bromide is prepared by taking 196 parts of bromide of ammonium and 272 parts of bromide

of cadmium and treating them as in the preparation of the double iodide.

The iodized collodion is made up as follows:

Double iodide	6 grains
Ether	½ ounce
Alcohol	½ ounce
Pyroxyline	2 grains

To make the bromized collodion take

Double bromide	10 grains
Alcohol	3 drams
Ether	5 drams
Pyroxyline	2 grains

For special use these collodions are mixed in the following proportions:

For interiors and dimly lighted subjects, two parts iodized to one part bromized.

For quick exposures, three parts iodized to one part bromized.

For copying and process work, five parts iodized to one part bromized.

Mr. Carbutt states that this collodion should be allowed to ripen for six or eight weeks before it is used. If a few drops of tincture of iodine are added, it will be in good working order in a few days.

DR. VOGEL'S COLLODION.

Iodide of cadmium	1 part
Iodide of sodium	½ part
Bromide of ammonium	½ part
Alcohol	30 parts

After filtration one part, by measure, of the filtrate is added to three parts, by measure, of plain collodion, containing two per cent. of pyroxyline. The mixture may be used after three days.

EQUIVALENT COLLODION.

a.	Iodide of cadmium	18 parts
	Alcohol	270 parts
b.	Bromide of cadmium	17 parts
	Alcohol	270 parts

Two measured parts of *a* are added to one measured part of *b*, and nine measured parts of plain collodion, containing two per cent. of pyroxyline.

This collodion will keep for years.

Care of the Collodion.—The proper care of the collodion is a matter of great importance to the photographer who wishes to secure uniformly good results.

The chemical changes which a salted collodion undergoes are manifested by a change of color to yellow and red, and by a decrease of sensitiveness. Red collodion may be corrected by the addition of cadmium collodion, which remains white for months.

A collodion which has a tendency to turn red should be mixed only as wanted for use, the plain collodion and the iodizer being kept in separate bottles.

The collodion also becomes thick by the evaporation of the solvents. When it becomes too thick to flow well it must be thinned down by the addition of a sufficient quantity of alcohol and ether in the proportions of three to five.

When the excess of collodion is drained from the plate into the stock bottle it gradually becomes filled with dust, giving rise to spots on the plates. This evil may be avoided by draining the excess into a separate bottle. After settling for a week the clear liquid can be decanted off and used for coating.

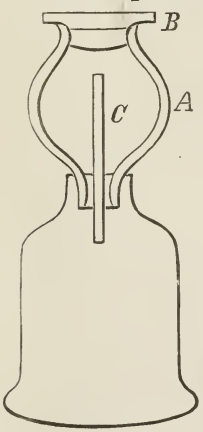

FIG. 16.

The neck of the stock-bottle should be kept covered with a bell glass, and the stopper should be left out as little as possible to prevent evaporation.

Filtering Collodion.—Many collodions settle so slowly as to require a tedious length of time to render them fit for use unless filtered.

Fig. 16 shows a collodion filter. *A* is a glass funnel fitting closely into the neck of the bottle, and closed by the glass stopper *B* to prevent the evaporation of the collodion. *C* is a piece of glass tubing, around which washed cotton is loosely packed, through which the collodion slowly filters.

The Sensitizing Bath.—The office of the bath is to make the collodion film sensitive by changing the metallic iodides and bromides into iodide and bromide of silver.

The utmost care and cleanliness must be exercised in the preparation of the bath, and a generous amount of it should be made up. It is customary to add a trace of iodide of potassium to prevent the bath eating away the film, owing to the solubility of iodide of silver, in a solution of nitrate of silver. Dilute nitric acid is also added sparingly when the plates show signs of veiling. Other additions are sometimes recommended, but their utility is doubtful.

The strength of the bath varies somewhat according to the nature of the work in hand; from 35 to 50 grains of silver to the ounce may be taken as the limits in either direction.

Dr. Vogel recommends the following:

Nitrate of silver (neutral)	100 parts
Distilled water	1000 parts

To which are added 25 parts of 1 per cent. aqueous solution of iodide of potassium. If the bath gives veiled images, a 20 per cent. aqueous solution of nitric acid is added drop by drop until a trial plate developes free from fog.

Hardwich recommends the following baths:

For Bromo-Iodized Collodion.

Nitrate of silver	35 grains
Distilled water	1 ounce

The required quantity of solution is made up and iodized by the addition of a few grains of iodide of potassium.

If the bath shows a neutral or alkaline reaction acidify with dilute nitrate acid until blue litmus changes slightly to red.

For Iodized Collodion.

Nitrate of silver	30 grains
Distilled water	1 ounce

The bath is iodized as before, and, if necessary, made acid by the addition of acetic acid.

Great care must be taken when acidulating the nitrate bath not to add too much acid, which diminishes the sensitiveness of the film and gives weak images. The proper way is to add only a few drops at a time, and to sensitize, expose, and develop a trial plate after each addition until the image shows no deposit of silver in the deepest shadows, *i. e.*, until it is free from fog.

To correct a bath which is too acid the best plan is to add by degrees some non-acidulated nitrate solution of the same strength, testing with trial plates between each addition.

Management of the Bath.—Collodion plates sensitized in a freshly made bath generally give clear and brilliant negatives, but by constant use the bath undergoes a change; it becomes charged with alcohol and ether, with the nitrates of potassium, ammonia, cadmium, etc., the products of double decomposition, with various substances derived from the pyroxyline, with dust and impurities from various sources. In this condition the bath will not produce good results; it must be purified.

The insoluble substances contained in an old bath are easily removed by filtration. The soluble organic substances are destroyed by exposing the bath to sunlight. Under the action of light the greater portion of the organic matter is burnt up, as it were, by the nitrate of silver, which is at the same time reduced and a slight trace of nitric acid is given off which aids the production of pure and brilliant negatives. The bath should be "sunned" occasionally when not in use.

With long use the bath becomes so charged with alcohol and ether as to be unfit for use until these have been removed by evaporation. For this purpose the bath may be poured out into a large tray and left uncovered for some hours, when most of the alcohol and ether will have evaporated. The process may be hastened by the application of heat When this method is adopted the bath after evaporation must be made up to its original volume by the addition of distilled water. If turbidity is produced by this addition, the bath is filtered, and acetic acid added drop by drop, until a trial plate gives a perfectly clear negative.

When the volume of the bath has become very much reduced, it may be increased by making up a new bath, observing the following precaution: To the old bath sufficient distilled water is added to bring it up to the volume desired. This addition produces a yellowish discoloration, due to the precipitation of iodide of silver; this is removed by filtration, after which sufficient nitrate of silver, in crystals, is added to bring the bath up to the proper strength.

If these simple precautions be taken no trouble need be feared from the silver bath, and they are all that are required.

Testing the Strength of the Silver Bath.—An approximately correct determination of the strength of the bath can be arrived at by the use of the argentometer, an instrument graduated to register grains of silver to the ounce of water.

The accuracy of this test is greatly impaired by the presence of foreign matter in the solution. Since these are nearly always present in the sensitizing bath, the chloride of sodium test should be applied when accurate knowledge of the exact strength is necessary or desirable. Hardwich gives the following simple method of applying this test:

Pure crystallized chloride of sodium is dried by heat, to eliminate the water of crystalization, and dissolved in distilled water in the proportion of eight and one-half drams to six fluid ounces. This forms a standard solution, each dram of which will precipitate half a grain of silver.

One dram of the bath is accurately measured out in a minim graduate and placed in a two-ounce stoppered phial, the graduate is rinsed out with a dram of distilled water, which is added to the dram of bath. A little bichromate of potash is then added to the contents of the phial; its effect is to form a deep red precipitate of chromate of silver.

Two or three drams of the standard salt solution are next placed in a graduate and added to the contents of the phial, in the proportion of one dram for every four grains of nitrate known to have been present. The contents of the phial are then well shaken, and then examined to note if the red coloration shows any lessening of tint. Further additions of the salt solution are added, fifteen drops at a time, until the red coloration disappears, owing to the decomposition of the red chromate into the white chloride. The volume of salt solution used is then determined, when a simple calculation will give the number of grains of silver in the original dram.

The following example will make the method plain: In case the bath is thought to contain about 20 grains to the ounce, then one dram will contain two and one-half grains; half a dram of the salt solution is added and the whole well shaken, subsequent

additions must be made more cautiously, a few drops at a time, followed by vigorous shaking. If it is found that 40 drops of the salt solution were required to produce the change of color, the number of grains of silver in the tested dram was evidently $\frac{40}{60}$ or $\frac{2}{3}$ of 4 = $2\frac{2}{3}$ grains or $21\frac{1}{3}$ grains to the ounce.

If pure chloride of sodium can not be obtained, ordinary chloride of ammonium may be substituted in the proportion of $7\frac{3}{4}$ grains of the chloride to 6 ounces of water.

Development.—A solution of sulphate of iron is generally employed as a developer for the negative. This solution has the property of precipitating silver from its solution as a fine metallic powder. The same precipitate is formed when a solution of iron is poured over a collodion plate still wet from the silver bath. The formation of the precipitate is, however, confined to those parts of the plate which have been acted upon by light, and in this way the image is built up.

To prevent the too rapid formation of the precipitate a dilute and acidulated solution is used.

For pictures with half tones, portraits, landscapes, etc., Dr. Vogel recommends the following developer:

Sulphate of iron	3 parts
Glacial acetic acid	3 parts
Water	100 parts

When an old nitrate bath is used two parts of alcohol should be added to the developer.

A typical American developer is

Sulphate of iron	1 ounce
Water	16 ounces
Acetic acid	1 ounce

For soft effects in portraiture the following is recommended:

Sulphate of iron and ammonia	1½ ounces
Acetic acid	1 ounce
Water	16 ounces

The sulphate of iron solution must be freshly mixed every two or three days. The sulphate of ammonia and iron modification will keep for a long time.

Intensification.—In many cases the developed image is too weak to be printed from with good results; it must then be

strengthened by the process called intensification. This is effected by pouring on the plate a silver solution combined with some reducing agent, usually pyrogallic acid or sulphate of iron.

The following formulæ will produce good results:

a. Pyrogallic acid..... 1 part
Alcohol.....10 parts

b. Nitrate of silver..... 2 parts
Citric acid..... 3 parts
Water.....100 parts

This solution will keep for two weeks.

For use dilute a small quantity of *a* with twenty-five parts of water and mix with an equal volume of *b*.

In summer four parts of citric acid may be used instead of three, to retard the action of the intensifier. In winter it will be well to reduce the proportion to one part. The plate must be well washed before the solution is applied.

The iron intensifier is as follows:

a. Sulphate of iron..... 3 parts
Glacial acetic acid..... 3 parts
Water.....100 parts

b. Nitrate of silver..... 2 parts
Citric acid..... 3 parts
Alcohol.....2 to 3 parts
Water.....100 parts

Equal volumes of *a* and *b* are taken to form the intensifier. The advantage of this method is that the plate need not be washed after development. It is much better not to intensify, but to give the proper density to the negative by development.

Fixing.—The object of the fixing-bath is to remove the unreduced iodide and bromide of silver, and so protect the picture from further changes through the action of light. For this purpose either a 1 to 5 solution of hyposulphite of soda or a 1 to 20 solution of cyanide of potassium is employed.

The only objection to the use of hyposulphite of soda as a fixing agent is the prolonged washing necessary to remove it from the film.

Cyanide of potassium is more easily washed away, but it is a deadly poison, and attacks the half-tones unless quickly removed by washing.

Practical Manipulations.

Collodionizing.—The plates to be collodionized must have been previously cleaned, as described in Chapter IV.

To collodionize, the plate is held between the thumb and fingers of the left hand at the left lower corner, and brought into a horizontal position. The mouth of the collodion bottle is brought near the surface of the plate and sufficient collodion is poured on to cover two-thirds of the surface. The plate is then gently rocked, to secure an even coating over the entire surface, and the surplus is drained from the lower right-hand corner into a separate bottle, to be filtered before being added to the stock collodion.

As soon as the surface has become tacky, the plate is placed on the glass dipper and kept in a horizontal position until the lower corner has dried so that the collodion will tear. It is then ready for

Sensitizing.—The plate is lowered slowly and without stoppage into the silver solution contained in a vertical glass bath. Any interruption in this operation will produce lines visible in the finished negative.

At first the alcoholic film repels the bath, which will run off the plate in greasy lines, if it is removed shortly after immersion.

The plate must remain in the bath until these greasy lines disappear, being gently moved up and down. It is then placed in the same position on blotting-paper, with its top against the wall, and allowed to drain, after which it is placed in the holder, care being taken that the edge of the plate which left the bath last occupies the lower end of the holder.

Sensitizing in Trays.—The plates may be sensitized in trays. This method requires less silver solution than that with the vertical bath, but care must be taken to remove the scum which forms on the surface with a piece of clean paper.

One end of the tray is raised slightly higher than the other, and a sufficient quantity of the silver solution is filtered into it to cover rather more than half of the bottom, one end of the plate is placed in the bath, and the plate is then lowered, face down, by means of a horn or silver hook. The liquid flows

between the glass and the bottom of the tray by capillary attraction and so covers the whole film. This method is recommended for experimental work on a small scale, as being more economical.

Another method is to lower the plate film up into the solution placed in a tray having a tank at one end.

The tray is placed in a vertical position, the plate is placed in the tray, which is then rapidly lowered.

Exposure.—No definite instructions can be given as to the proper time of exposure, which depends on the chemical intensity of the light, the brightness of the object to be photographed, and the size of the diaphragm.

The plate-holder must be kept always in the vertical position, to prevent the running back over the plate of the silver solution which collects at the bottom.

It is essential that all the operations at the camera be done rapidly, as the plates will keep moist only a short time.

Development.—The plate, after exposure, is taken into the dark-room, always being kept in its original vertical position. It is removed from the plate-holder inclined towards the edge which was lowest in the holder.

The developer is then poured on the upper part of the plate in such a way as to cover the whole plate with one sweep. This must be done gently and with care, to avoid unequal reduction of the silver.

The image now becomes visible, the high-lights appearing first, and gradually gains in detail and density. The operation must be watched with great care, and fresh additions of the developer made when necessary, the plate being kept in constant but not violent motion.

If, after long-continued development, the details in the shadows do not appear, the plate was under-exposed and is worthless.

If, on the contrary, all the details appear, but the image is wanting in contrasts, the exposure was too long, and the plate must be intensified. When fully developed, the plate is washed, and if not sufficiently dense, it is intensified before fixing.

Intensification.—The intensifier, mixed as directed on page 61, is poured over the plate and allowed to act until sufficient density is reached; it is then thoroughly washed and fixed. The intensifier must be rejected as soon as it becomes turbid. Intensification may be done after fixing.

Fixing.—The plate is immersed in either of the fixing solutions given on page 61, until the last trace of iodide of silver has disappeared. It is then well washed and dried.

Varnishing.—The instructions given on page 31 may be followed here.

Defects.—The most common defects in collodion negatives are the following:

Fog: due, *a*, to dirty plates; *b*, to want of acid in the developer; *c*, to over-exposure; *d*, to an alkaline bath solution; *e*, to improper exposure to white light; *f*, to vapors in the developing-room.

Weak images: due, *a*, to a poor collodion; *b*, to a weak sensitizing solution; *c*, to a bath charged with organic matter; *d*, to bad lighting of the subject; *e*, to an over-strong developer.

Pin-holes: due, *a*, to dust on the plate; *b*, to an over or under-iodized bath.

Black specks: due, *a*, to dust in the camera, slide, dark-room, or collodion.

Comet-like spots: due to undissolved particles of pyroxyline in the collodion.

Transparent spots: due to dust in the collodion.

Scum on the film: *a*, the plate has been kept too long out of the bath; or, *b*, the developer was too strong.

Wavy lines on the film: either the collodion contains too much iodide or alcohol, or the pyroxyline is too strong,

Transparent markings: due, *a*, to unequal sensitizing, or, *b*, to the developer refusing to flow.

Blurring of the image: due to reflections from the back of the plate; it may be diminished by coating the back of the plate with some non-actinic color, such as sienna, mixed in gum-water.

CHAPTER VII.

THE COLLODION PROCESS. DRY PLATES.

Hardly had the wet collodion process established itself in public favor before attempts were made to make it more suitable for the landscape photographer by giving him dry collodion plates, of fair keeping qualities. Up to the time when the gelatine process was introduced, the zeal of experimenters knew no flagging, and many valuable dry plate processes were elaborated by skillful workers. The fact that all of these processes have been almost entirely superseded by the gelatine dry plate, does not make a description of some of the best unnecessary or out of place. They have a value still, notably for the economical production of lantern slides on a large scale, while the Taupinot process gives results extremely difficult to be equalled by the more modern method.

Success in these processes depends on the strict observance of the following principles:

Firm adherence of the sensitive surface.

Permeability of the collodion film.

The use of a large proportion of bromide.

Complete elimination of all the free nitrate of silver by copious washing.

The use of a preserver to give keeping qualities to the plates.

The use of alkaline, or other similar developers to reduce the bromide of silver to the metallic state.

The strict observance of all the details given under each of the processes described, will enable the operator to meet all these conditions and make success certain.

Taupinot's Collodio-Albumen Process.—This method gives negatives of fine detail and exquisite delicacy. The manipulations are not over difficult, and the plates are fairly sensitive.

The manipulations may be thus summarized: The plates, previously polished with French chalk, or flowed over with a thin film of albumen, as described in Chapter V., are collodionized as usual with any of the collodions given in the previous chapter. They are then sensitized in the nitrate bath, well washed, and given a coating of iodized or iodo-bromized albumen, which destroys the sensitiveness conferred by the silver bath. When dry the plates will present a brilliant, opalescent appearance, and can be preserved indefinitely. When wanted for use they are sensitized in an acidulated silver bath, thoroughly washed, and then flowed with a solution of gallic acid to preserve them. In this condition they will retain their good qualities for two weeks.

Manipulations.—Collodionize as usual; stand the plate on one corner on two or three thicknesses of blotting paper, supporting it against the wall, face down. After a minute's standing, sensitize as usual on the following bath:

Water	3½ ounces
Nitrate of silver	100 to 125 grains
Nitric acid	3 or 4 drops

This bath should be filtered occasionally, kept acid, and stood in the sun when not in use.

After being sensitized the plate is washed in three or four changes of pure water, and then allowed to drain, one of the lower corners being supported in a beaker, the upper corner resting against the wall, the film side being uppermost.

After being well drained the plate is coated with the following albumen solution:

Albumen	3½ ounces
Bromide of ammonium	3½ grains
Iodide of ammonium	15 grains

The albumen must first be beaten and treated as described on page 40.

A more simple method is that of Mr. Ackland. Place the whites of several eggs in a large graduate, and for each three and one-half ounces of albumen add two drams of a 1 to 10 solution of glacial acetic acid; gently stir the mixture with a glass rod until the albumen becomes fluid, then allow it to stand for

two hours; then decant the clear portion into a funnel, having a piece of sponge in the tube; when this has filtered through, pour in the balance of the liquid. Before using, the albumen must be again filtered through filter paper, avoiding air bubbles by bringing the tube of the filter in contact with the side of the glass, or by the method of upward filtration before described.

This solution is flowed over the plate like collodion, and the plate is drained as described above. When well drained it is dried in the drying box, or spontaneously in the open air, supported vertically, so that no part of the film is in contact with any foreign substance.

When dry the plates, which are insensitive, will keep indefinitely.

To sensitize they are immersed in the following bath:

Water	3½ ounces
Nitrate of silver	100 grains
Glacial acetic acid	2 drams

Each plate remains in the bath one-half a minute; it is then washed in four changes of distilled or filtered water and the gallic acid preservative flowed over it, (water, thirty-five ounces; gallic acid, seventy-five grains); this is applied twice, and the plate is then dried. Plates prepared in this way will retain their good qualities for two weeks.

Exposure and Development.—The time of exposure varies from four to ten minutes, according to circumstances.

The image is developed with either of the following developers:

Water	35 ounces
Gallic acid	45 grains
Pyrogallic acid	45 grains
Glacial acetic acid	4 drams

The plate is placed in a tray and sufficient of this solution poured over it to cover it. While this is acting one to two drams of a one to twenty-five solution of nitrate of silver are placed in a graduate, and the contents of the tray poured into it. The liquid is then returned to the tray; the image will soon appear and rapidly gain in detail and density.

The following developer will generally be found the best:

a.	Water	35 ounces
	Carbonate of ammonia	155 grains
	Bromide of potassium	1 grain
b.	Water	35 ounces
	Pyrogallic acid	155 grains

Mix *a* and *b* in equal parts and pour over the plate previously soaked in distilled water. The image will appear almost immediately, and should show no signs of fog. If fog appears, due to over-exposure, add a few drops of a one to ten solution of bromide of potassium.

The action of this developer should be stopped before all the details in the shadows are visible, and the development completed in the gallic and pyrogallic solution given above. The plate is immersed in this for a moment until the acetic acid has removed all traces of alkalinity; it is then removed from the developer, to which a few drops of a one to twenty-five nitrate of silver solution are added, and the plate returned to the tray. Development is soon completed; the plate is then washed and fixed in a one to five hyposulphite of soda solution, after which it is washed, dried, and varnished as usual.

Boivin's Process.—This method gives negatives of the very highest grade, free from danger of frilling, full of detail in the shadows, and with the distances properly rendered. The sensitized plates retain their good qualities for months.

Manipulations.—The plates are first well cleaned, and then without any previous coating they are collodionized as usual with the following collodion:

Ether	17 drams
Alcohol	11 drams
Nitrate of silver	15 grains
Pyroxyline	15 grains

The nitrate of silver is placed in a glass-stoppered bottle, one or two drops of distilled water are poured over it, and when the silver is dissolved, or nearly so, the alcohol is added, and the bottle shaken until solution is complete; then the ether and the pyroxyline are added, and the bottle again shaken. The resulting collodion must be allowed to ripen for

twenty-four hours before being used. If found too thick to flow well, sufficient alcohol and ether in the proportions of four to six must be added to thin it down. The collodion will keep indefinitely in a dry, dark place.

As soon as the collodion is set, the plate is immersed without stoppage in the following bath :

Distilled water	3½ ounces
Iodide of cadmium	30 grains
Iodide of ammonium	15 grains
Iodide of potassium	30 grains
Bromide of potassium	20 grains

As soon as all traces of oiliness have disappeared, the plate is taken from the bath and washed in four changes of pure rain water, and then inclined against the wall, face down, to drain, blotting paper being placed under the lower edge.

The next step is to cover the film with an albumen solution prepared as follows :

Whites of six eggs beaten to a froth	
Distilled water	2 ounces
Dextrine	90 grains
Glucose	90 grains
Iodide of potassium	22 grains
Bromide of potassium	17 grains
Iodide of ammonium	22 grains
Bromide of ammonium	7 grains
Iodide in pellets	5 grains

The dextrine and the glucose are first dissolved in the water by heat, the water lost by evaporation is replaced; the salts are then dissolved, and the solution is added to the albumen and whole well shaken; a few drops of ammonia are then added and the solution is allowed to stand some hours before being used. It is then filtered and flowed over the still moist plate; two thin coatings are given to the plate, which is then dried at a temperature of about 70 deg. The plates will keep indefinitely.

Sensitizing is effected by plunging the plates rapidly and without stoppage in the following bath :

Distilled water	3½ ounces
Nitrate of silver	95 grains
Glacial acetic acid	2½ drams
Iodide of potassium	10 grains

The plates are immersed for one minute, and then washed in three or four changes of distilled water. The first wash water being preserved in a well-corked bottle for use in development as explained later on, finishing up with a good washing under a rose, or with a pipette. They are then dried in the dark.

M. Boivin claims that these plates will retain all their good qualities for six months, and the author can certify to the good results obtained from them with exposures varying from one to five minutes.

Development.—The exposed plate is immersed for a few minutes in the wash water preserved for this purpose as directed above; it is then immersed in a bath prepared as follows:

Solution of gallic acid (1 to 250)	3½ ounces
Rain water	3½ ounces
Solution of acetate of soda (1 to 20)	4 ounces

If the details develop too slowly add a few drops of a ten-grain solution of nitrate of silver.

When the details are well out strengthen with the following:

Distilled water	9 ounces
Pyrogallic acid	15 grains
Glacial acetic acid	3 to 4 drams

If the negative is flat and lacks vigor, substitute the following:

Distilled water	9 ounces
Pyrogallic acid	15 grains
Citric acid	20 to 30 grains

If detail is wanting immerse the plate in a strong gallic acid solution containing a little nitrate of silver.

Fix in a saturated solution of hyposulphite of soda.

M. Boivin recommends the following modifications in the preparation, to produce still greater perfection of results. They are not, however, indispensable.

After sensitizing and washing as usual, the plates are immersed in a one per cent. solution of bromide of potassium,

then washed and immersed in a twenty per cent. solution of pyro, to which a few drops of acetic acid have been added. They are then well washed by pouring water over them from a flask and dried as usual. Plates thus prepared seem to keep better, are more sensitive to feeble light, and yield plucky negatives, full of fine detail in foliage.

The Tannin Process.—The plates are collodionized with one of the following collodions:

No. 1.

a.	Pyroxyline (very soluble)	61 grains
	Ether	5⅜ ounces
	Alcohol	2⅝ ounces
b.	Iodide of cadmium	135 grains
	Iodide of ammonium	37½ grains
	Bromide of cadmium	112 grains
	Alcohol	12⅞ ounces

Mix three parts of *a* with one of *b*, and add enough iodine to give a slight tinge of color.

Sensitize in a ten per cent. nitrate bath, slightly acidified with nitric acid.

No. 2.

Pyroxyline	38½ grains
Bromide of cadmium	77 grains
Bromide of ammonium	20 grains
Alcohol	5⅜ ounces
Ether	5⅜ ounces

In this case sensitize in a fifteen per cent. nitrate bath.

After sensitizing, wash well and flow twice with the following preservative:

Distilled water	3½ ounces
Tannin	30 to 45 grains

and dry as usual.

These plates retain their good qualities for about two weeks, but they are slow.

Development.—The following developer is recommended:

Carbonate of ammonia	75 grains
Distilled water	24 ounces
Alcohol	12 ounces

First well moisten the plate in a sufficient quantity of this

solution; then pour the developer into a graduate and add a few drops of a fifty grain alcoholic solution of pyro, and pour back on the plate. More pyro may be added if necessary to give density. Fix and wash as usual.

Sutton's Method for Instantaneous Views.—Sensitize the plates on a plain bromized collodion containing 45 grains of bromide to every 3½ ounces of normal collodion; sensitize on an eighteen per cent. nitrate bath. After washing and draining flow the plates with the following preservative:

Albumen	1 part
Water	2 parts
Glycerine	1 part

Dry as usual and use the same day.

Develop in the alkaline bath given for the tannin process, or in the sulphate of iron bath; in the latter case the plate must be immersed in a four per cent. solution of nitrate of silver after washing. Fix and wash as usual.

The Gum Gallic Process.—The process now to be described is a modification of that of Mr. Manners Gordon. Plates thus prepared give good detail in foliage, with an exposure varying from ten to sixty seconds, but they cannot be kept longer than four or five days.

The plates are first given a thin coating of dilute albumen, to promote adhesion of the film; they are then collodionized with a collodion containing equal quantities of the iodides and bromides; sensitized in an eight per cent. nitrate bath and well washed, the last wash water containing a slight trace of pyro-gallic acid and a drop of glacial acetic acid. They are then drained and flowed with the following preserver, well filtered:

Water	3½ ounces
Gum arabic	60 grains
Glucose or sugar candy	15 grains

Develop with Boivin's developer, given above. Fix and wash as usual.

CHAPTER VIII.

COLLODION EMULSION. COLLODIO-BROMIDE OF SILVER.

Many attempts were made at various times to simplify the collodion process by manufacturing a collodion containing the sensitive substances suspended in a state of extremely fine division.

The first efforts in this direction seem to have been made as early as 1853 by M. Gaudin, a French experimenter, but he did not fully work out the method. It was not until 1864 that the process came into general use, owing chiefly to the publication in that year by Messrs. Sayce and Bolton of the results of their experiments with collodio-bromide emulsion. During the next ten years many formulæ were published for preparing plates by the new method. A few of the best of these have been selected for detailed treatment, including the process of M. Chardon, which, in 1875, won the prize offered by the French Photographic Society for the best set of formulæ for working this process.

As it seems highly probable that collodion emulsion will be increasingly employed, especially for the production of transparencies, and as success with the process depends upon the attention paid to various details which are not of paramount importance in the wet collodion process, it has been thought advisable to give a few hints on points likely to be neglected by the experimenter. These general notes will, it is hoped, serve to clear the way for the more detailed description of the typical processes given later in the chapter.

The Pyroxyline.—For washed emulsions it is better that the sample of pyroxyline employed should not be that known as high temperature cotton. The most suitable pyroxyline for

this class of work is the somewhat tough or horny variety, produced when ordinary cotton is dissolved in a preponderance of sulphuric acid, at a temperature varying from 140 to 150 deg. The after-washing of the emulsion seems to produce a change in this kind of pyroxyline, making it eminently suitable for emulsion work.

The Bromides.—As a matter of convenience it is best to use the bromides of ammonium, cadmium, and zinc. But owing to the insolubility of the former salt in alcohol it must be combined with the bromide of cadmium to form the double salt of ammonium and cadmium, which is sufficiently soluble in alcohol to give a highly salted collodion.

The double salt is easily made by placing the proper quantities of the two salts in a mortar, and then to mix them intimately with the pestle. The water of crystallization is thus separated, and a pasty mass is formed, which is dried in an oven ; when thoroughly dry it is ready for use.

Bromide of zinc gives a richer and closer film than either of the others, and is therefore not so suitable for slides and transparencies.

Making the Collodion and Emulsion.—The best method is to make up the plain collodion first, reserving, however, a part of the alcohol to be used later. When an emulsion is to be made, the bromides are placed in the emulsifying bottle and the proper quantity of plain collodion poured over them, and the bottle shaken until the salts are dissolved. In this way there is absolute certainty of having the amount of bromide necessary to convert the silver.

The silver is to be dissolved in the reserved alcohol. This is a slow and tedious operation, but it may be greatly hastened by dissolving the silver in the smallest possible quantity of distilled water, and then adding the alcohol at its boiling point. Nitrate of silver is dissolved in rather less than half its weight of boiling water. If then the required weight of silver be placed in a test tube, and half as many drops of water added as there were grains of silver, the latter may be dissolved by holding the test tube in the flame of a lamp until the water boils. The alcohol is then added in small quantities, and the

solution is re-heated after each addition. Or if the alcohol has been previously brought near its boiling point it may all be added at once without precipitating the silver. The silver solution should be heated nearly to boiling before it is added to the bromized collodion to avoid danger of crystallization. The flask is always to be washed out with a small quantity of alcohol reserved for that purpose, and, finally, with some of the emulsion itself to obtain every trace of silver.

Ripening the Emulsion.—This process is necessary to the production of that creamy condition which is essential to good results. The length of time required to attain this creaminess varies with different emulsions. Those in which an excess of silver nitrate is present will be sufficiently ripened in a few hours; while those in which the bromide is in excess may require days, and even weeks to reach their best condition. The ripening process can always be hastened by adding a small quantity of an old emulsion in good condition.

Washing and Organifying.—Washing is a most important matter. The best method for small batches is to pour the emulsion out into a clean dish of sufficient size to allow it to set in a thin layer, and when set to wash in many changes of water, the last change being distilled water. If it is proposed to use an organifyer, the better mode of using is to allow it to act a quarter of an hour upon the set film before washing is begun.

For re-dissolving the emulsion, always use a flask of double the capacity required to hold the emulsion. This allows room for vigorous shaking. The above method of working is recommended by Mr. Bolton, and it is a safe one to follow.

Chardon's Method.

For the successful working of this process, the two kinds of pyroxyline described in Chapter V. are necessary.

These are dissolved in separate mixtures of ether and alcohol, and the solution allowed to settle. The clear liquid is then decanted, and the pyroxyline precipitated from both solutions by pouring the collodion from a height in a fine stream into a dish of pure water, stirring well during the pouring and for a short time afterwards. The effect of this is to deprive

the pyroxyline of its solvents, and to precipitate it in a spongy mass. The stirring must be continued until the precipitated mass feels firm and hard to the touch. The water is then poured off, the cotton passed through a cloth and dried. It is then suitable for use in making up the following collodion:

Alcohol	1 ounce
Ether	2 ounces
Double bromide of cadmium and ammonium	14 grains
Zinc bromide	14 grains
Precipitated pyroxyline, common	7 grains
Precipitated pyroxyline, made by the nitrate of potassium method	28 grains

A stock of this can be made up, as it keeps well. It should not be filtered, but should be decanted off when wanted.

The sensitive modification, or collodio-bromide emulsion, is produced by adding to each ounce of the above collodion 6.2 grains of finely-powdered nitrate of silver dissolved in 3 ounces of alcohol. To effect solution, the powdered nitrate is placed in a flask with a few drops of distilled water; solution is produced by gentle heat; the alcohol is then added and the precipitate first formed is re-dissolved by heat. This solution is added, drop by drop, to the given quantity of collodion. The apparatus shown in Figure 17 will be found very convenient for this purpose, as well as for others, when a finely divided emulsion is required.

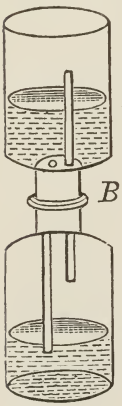

FIG. 17.

A and *C* are two flasks; *B* is a cork, through which are passed two glass tubes as shown, the lower end of the tube projecting into the bottle, *C*, having been drawn to a point, and then filed off, thus leaving a small orifice.

The collodion is placed in the lower flask, the silver solution in the upper. By vigorous shaking, the nitrate solution is made to pass, drop by drop, into the collodion, and in this way a very finely-divided emulsion is produced, which may be tested by pouring a few drops on a glass, and examining it by white light. If it shows a bluish tint by reflected and an orange tint by transmitted light, the operation has been successful thus far.

The emulsion is now set aside in the dark for thirty-six hours, to settle and ripen.

The next step is to test for silver nitrate, which must be slightly in excess. For this purpose, an ounce of distilled water is placed in a beaker glass, and a dram of the emulsion poured into it; the mixture is well shaken, and then filtered twice, or until clear, through filter-paper. The addition of a few grains of common salt to the waste water will indicate the presence of free nitrate by a slight milkiness, due to the formation of chloride of silver. If no change in color is visible, a sufficient quantity of the alcoholic nitrate solution is added to the collodion, to produce a slight milkiness in the wash-water.

In order to secure immunity from fog it is well to add at this stage to every ten ounces of emulsion two drams of the following cobaltic collodion:

Alcohol	1 ounce
Ether	1½ ounces
Chloride of cobalt	60 grains
Pyroxyline	12 grains

The finished emulsion is next poured in a fine stream into a large quantity of water, with constant stirring. This precipitates the emulsion and removes from it most of the useless or harmful bye-products. The precipitate is washed in many changes of filtered water, and finally in one change of distilled water. It is then drained in a cloth and dried on several thicknesses of blotting paper. When dry the resulting powder may be preserved indefinitely by placing in a clean bottle well wrapped in non-actinic paper.

Re-emulsification.—To make the final emulsion for coating the plates, 17 grains of the sensitive powder are dissolved in the following solution:

Alcohol	½ ounce
Ether	½ ounce
Precipitated quinine	1 grain

The precipitated quinine is made from common sulphate of quinine by dissolving it in sulphuric acid and precipitating with ammonia.

The precipitate is first added to the alcohol, then filtered and the ether added, and lastly the sensitive powder. The mixture is allowed to stand for some hours in the dark, being occasionally shaken; it is then filtered through cotton wool and used to coat the plates.

Develop with any of the usual developers.

These plates keep well, but are not more than one-half as quick as ordinary wet plates.

Cooper's Process.

THE PLAIN COLLODION.

Alcohol	6 ounces
Ether	10 ounces
Pyroxyline, ordinary	160 grains

THE EMULSION.

a.	Alcohol	5 ounces
	Bromide of zinc	400 grains
b.	Alcohol	3 ounces
	Nitrate of silver	150 grains

Dissolve as recommended above.

To make about ten ounces of emulsion add one ounce of *a*, and all of *b*, to three ounces of the plain collodion; then add twenty drops of syrupy lactate of ammonia. The silver solution should be at the boiling point when added to the collodion. The zinc solution will throw down a deposit after being kept, which must not be disturbed.

The emulsion will ripen in twenty-four hours, but better results are obtained by allowing it to stand for three days; then add twenty drops of strong nitric acid and shake well.

Wash first in a very dilute solution of nitric acid, one-half an ounce of acid to one gallon of water, then in many changes of pure water, and dry thoroughly.

When dry dissolve the pellicle in five ounces of alcohol and the same quantity of ether.

The plates are first coated with the following gelatine substratum:

Gelatine	60 grains
Water	8 ounces
Chrome alum (10 grain solution)	2 drams

The gelatine is swelled in cold water, well drained, and

enough boiling water added to make the bulk up to eight ounces. Then the alum solution is added and the mixture well stirred for a few moments, and then filtered, avoiding air bubbles. This solution is flowed over the washed plates while still wet. Two coats are given, the first being drained away closely. The plates are then dried in an airy place, free from dust.

The plates are coated with the emulsion, and when the films are set they are to be well washed; a grooved negative washing-box answers well for this purpose. Wash until all signs of greasiness have disappeared, and then immerse for one minute in the following bath:

Albumen, dried	60 grains
Water	3 ounces
Ammonia	1 dram

Again wash well, flow over with a two-grain gallic acid preservative, drain and dry.

These plates seem to possess indefinite keeping qualities, develop well with any good alkaline developer, and possess great latitude of exposure. They should be backed to prevent halation. A good backing is made as follows:

Powdered burnt sienna	1 ounce
Gum	1 ounce
Glycerine	2 drams
Water	10 ounces

This is applied to the back of the plate with a stiff brush, and washed off with a damp sponge previous to development.

Capt. Abney's Collodio-Albumen Emulsion.

PLAIN COLLODION.

a.	Alcohol	4 drams
	Ether	6 drams
	Pyroxyline	16 grains

BROMIDE SOLUTION.

b.	Bromide of zinc	16 grains
	Chloride of calcium	4 grains
	Alcohol	1 dram

Add bromine water to impart a yellow tint.

ALBUMEN SOLUTION FOR EACH HALF OUNCE OF COLLODION.

c.	White of egg	8 drops
	Alcohol	1 dram

Add the albumen in drops and stir well.

First add *b* to *a*, and then drop in the proper quantity of *c*, and stir well. Then by the method given on page 76 add forty grains of nitrate of silver, previously dissolved in the smallest quantity possible of water and hot alcohol.

The emulsion is then poured out into a shallow dish to set; it is then washed as usual. Capt. Abney recommends covering it with a weak solution of nitrate of silver after the second washing, and then to continue the washing until the traces of silver are very faint.

The pellicle should be re-dissolved in equal quantities of ether and alcohol, in the proportion of seven grains of the pellicle to each ounce of the mixed solvents.

After being coated, the plates are well washed, flooded with a two-grain gallic acid preservative, and dried.

These plates are more rapid than ordinary wet-plates, and can be developed with any of the alkaline or ferrous oxalate developers.

Capt. Abney's Collodio-Chloride Emulsion, with Excess of Chloride.

This emulsion can be used within a quarter of an hour of its preparation. The process is described in Captain Abney's own words.

Weigh out the following:

Pyroxyline, easily soluble	10 grains
Pyroxyline, easily soluble	5 grains
Chloride of calcium	20 grains
Nitrate of silver	50 grains

Dissolve the calcium in one-half ounce of alcohol, by warming over a spirit-lamp. Place the five grains of pyroxyline in a two-ounce bottle, and pour on it the alcohol containing the calcium. After a couple of minutes, add one-half ounce of ether, when the cotton will dissolve.

Dissolve the 50 grains of silver in a test tube in 25 drops of water, and add to it one ounce of boiling alcohol and mix. Previous to this, the 10 grains of pyroxyline should have been placed in a four-ounce bottle, and the alcohol containing the silver should be poured in. Next add one ounce of ether, little by

little, with continuous shaking. Take the two bottles into a room lighted by yellow light, and gradually pour the chloride of calcium collodion into the nitrate of silver collodion. A test plate should now be coated, washed under the tap, and placed in the dark slide. The slide should be taken into white light and half the front pulled up for a second and then closed. The ferrous citro-oxalate developer given below should then be applied and the result noted. The film should show no blackening except on the exposed half of the plate. Should blackening take place, add two or three drops of a 20-grain solution of chloride of gold or cobalt to the emulsion and shake well; the fog will then disappear.

There seems to be no advantage in washing the emulsion. The coated plates are washed and then flooded once with

Beer	5 ounces
White sugar	1 lump
Pyrogallic acid	5 grains

Or the two-grain gallic acid preserver may be substituted. These plates will be found quite sensitive.

They are developed with the ferrous citro-oxalate developer, prepared as follows:

Citrate of potassium, neutral	100 grains
Ferrous oxalate	22 grains
Water	1 ounce

First dissolve the citrate by heat, and, when nearly boiling, add the ferrous oxalate and shake well.

A weaker form of the same developer is

Citrate of potassium	50 grains
Ferrous oxalate	12 grains
Water	1 ounce

These solutions keep well when corked in bottles.

The plates are first rinsed in water, and then immersed in the developer. The image soon appears, and is of an ivory-black tone, well adapted to collodion transfers or positives on glass or paper. If a warmer tint is desired, tone with

Nitrate of uranium	10 grains
Ferricyanide of potassium	10 grains
Water	10 ounces

Canon Beechey's Process.

This is a very simple and reliable process. Plates made by it possess admirable keeping and technical qualities of about one-half the sensitiveness of average wet-plates.

The following solutions are made up:

1.—Bromized Stock Solution.

Bromide of cadmium (anhydrous)	300 grains
Alcohol (805)	8 ounces

The solution is allowed to settle until clear. The supernatant liquid is then carefully decanted off, and one dram of hydrochloric acid is added. In this condition the solution will keep for years.

2.—Collodion.

Bromized solution	½ ounce
Absolute ether	9 drams
Pyroxyline	12 grains

These ingredients are placed in a clean bottle and shaken until the pyroxyline is dissolved. The quantity given above is sufficient to coat one dozen whole plates.

3.—The Sensitizer.

Nitrate of silver	40 grains
Alcohol	1 ounce

The best way of effecting solution is to pulverize the silver in a mortar. The powder is then placed in a test tube, the alcohol poured over it, and boiled until solution is effected. It is then poured in a fine stream into the collodion, with constant stirring. The emulsion is allowed to stand for twenty-four hours in a dark place, being occasionally shaken. It is then ripe enough for use, and should have a creamy appearance.

The plates to be coated must first have been given a substratum. Any of those given in Chapter IV. will answer. They are then coated as usual, and, when set, washed in pure water until all greasiness has disappeared. They are then immersed in the preservative—stale beer thirty ounces, pyro thirty grains—and dried as usual.

Before coating, the emulsion should be well shaken and filtered.

Development.—Any good alkaline developer will work well with these plates. Before development the plates must be immersed in pure water to remove the preservative.

Developers for Collodion Emulsion Plates.

Alkaline Developers.

1.

a. Pyrogallic acid.....6 grains
Water.....1 ounce

b. Bromide of potassium.....20 grains
Water.....1 ounce

c. Ammonia.....1 ounce
Water.....32 ounces

To develop: Take two parts of *a*, two parts of *b*, and one part of *c*.

2.

a. Pyrogallic acid.....6 grains
Alcohol.....1 ounce

b. Bromide of potassium.....120 grains
Water.....1 ounce

c. Carbonate of ammonium.....80 grains
Water.....1 ounce

Six drops of *a*, three drops of *b*, and three drams of *c*, form the developer.

3.

a. Carbonate of ammonium (pure).....10 grains
Bromide of potassium.....2 grains
Water.....1 ounce

b. Pyrogallic acid.....50 grains
Alcohol.....1 ounce

One ounce of *a*, and fifteen drops of *b*, form the developer.

Ferrous-Oxalate Developer.

a. Ferrous sulphate.....160 grains
Water.....1 ounce

b. Oxalate of potassium (neutral).....1 ounce
Water.....3 ounces

Add one part of *a* to two parts of *b* immediately before wanted for use.

Hydrochinone Developer.

a. Hydrochinone. . . . . 12 grains
Sulphite of soda. . . . . 60 grains
Water. . . . . 1 ounce

b. Carbonate of soda. . . . . 60 grains
Water. . . . . 1 ounce

For the developer take two ounces of *a*, one ounce of *b*, and one ounce of water.

This developer, although expensive, is recommended by the author for fine work, especially for positives on glass or paper, on account of the velvety blackness of tone and the clearness of shadows obtained by it. The hydrochinone solution will keep indefinitely; the mixed developer can be used to develop many plates, and the developer does not stain.

Previous to development, the plates should be soaked in water or alcohol, as required, to remove the preservative. Gum or albumen preservatives dissolve only in alcohol. When the latter solvent is used, the plate must be washed in pure water until all repellent action has ceased. The developer is then poured over the plate. If the image is slow in appearing, pour off the developer and apply a new one containing less bromide, or add more of the alkaline solution.

Intensify, if necessary, with the following:

a. Pyrogallic acid. . . . . 2 grains
Citric acid . . . . . 2 grains
Water. . . . . 1 ounce

b. Nitrate of silver . . . . . 20 grains
Water. . . . . 1 ounce

Wash the plate well, and cover with *a*. Drop four or five drops of *b* into the graduate and pour the solution on the plate into it; then return the mixture to the plate and allow it to act until sufficient density is reached.

Defects.—Those most commonly met with in collodion emulsion plates are the following:

Black spots: due to dust settling on the film while drying.

Crape markings: due, *a*, to the solvents of the emulsion being too aqueous; *b*, to failure to shake the emulsion before

using it; or, *c*, to the bromide of silver being too coarse, owing to improper emulsification.

Difficulty in flowing the emulsion: due to a deficiency in the solvents.

The films leave the plates: the pyroxyline was too tough; use a more powdery kind.

CHAPTER IX.

THE GELATINE PROCESS.

Gelatine as a vehicle for the suspension of the sensitive salts of silver was recommended by Poitevin as early as 1850, but owing to the difficulty of obtaining it in the high state of purity necessary for photographic purposes, and the supposed greater facility and rapidity of manipulation possessed by collodion, Poitevin's suggestion found but little favor.

Maddox, King, Burgess, and Kenneth, during the years 1871 to 1874, published formulæ in which gelatine replaced collodion as the vehicle of suspension, but it was not till Bennett, in 1878, discovered the extreme sensitiveness conferred upon a gelatino-bromide emulsion, by digesting it at a high temperature, that the new process met with favor among photographers. From that time its advance has been rapid and continuous. Although the writer believes that it is a mistake to bring all photographic processes under the rule of the new claimant, he recognizes the immense advantages possessed by the gelatine method, advantages which may well outweigh any defects inherent in it.

It has been the custom to give the highest praise to the modern process on account of the extreme sensitiveness easily given to it. The writer, however, believes that its best claim for recognition is found rather on the artistic side.

In the old collodion days the operator having to prepare his plates himself as he had occasion to use them was under the temptation of unduly magnifying the chemical aspect of his work and to neglect somewhat the artistic.

But the advent of gelatine dry-plates has relieved the photographer from the task of preparing his plates, and left him free to devote all his care and thought to the production of artistic results. Art is ever averse to manipulation, and now that the photographer is to a great degree emancipated from the manipulatory miseries inseparable from the collodion pro-

cess. he has the opportunity of becoming more of an artist—of putting more of himself into his work.

Without touching upon the many other advantages possessed by gelatino-bromide plates, the author now addresses himself to the pleasant task of explaining the details of the production of the plates and the development of the image.

Preparation of Gelatine Emulsions.

General Observations.

Theory of the Method.—The preparation of the gelatino-bromide of silver consists essentially in forming a precipitate of bromide of silver in a warm solution of gelatine; this precipitate must be sufficiently fine to remain in suspension in the liquid in which it is produced; it is then said to be in a state of emulsion.

The sensitive bromide of silver is obtained by double decomposition, that is, by combining a soluble bromide with nitrate of silver; the result of this combination is the formation of insoluble bromide of silver and an alkaline nitrate corresponding to the bromide employed. This nitrate must be removed by washing.

It is necessary that the bromide be in excess in order to prevent fog and to regulate the action of the developing reagents. As a result of this there always remains in the emulsion a certain quantity of undecomposed alkaline bromide, which, unless removed by washing, would greatly lower the sensitiveness of the finished emulsion.

The most common mode of washing is to allow the emulsion to set, then to break it up into small pieces and to wash for some hours in many changes of distilled or filtered rain water. During the washing the emulsion gradually gains in sensitiveness, owing to the more complete removal of the alkaline nitrate and bromide. Hence the greatest precautions should be taken against exposing the emulsion to the action of any light save when absolutely necessary, and then only for the shortest possible time. After the washing is completed, the emulsion is freed from all excess of water by draining, then melted with gentle heat, filtered, and flowed over the plates, which, after the film is set, are dried and stowed away for future use.

Time, temperature, and degree of alkalinity affect the sensitiveness of gelatino-bromide emulsions.

At low temperature great sensitiveness is reached only after long digestion. If the temperature is raised to 100 deg. F. the same grade of sensitiveness is reached after five or six days. A temperature of 145 deg. F. will give the same result within three or four hours. If the emulsion be kept at the boiling point, thirty minutes gives the maximum of sensitiveness. These conditions are changed if any addition is made with a view to produce a chemical ripening. Ammonia is often employed for this purpose. This produces an alkaline condition in the emulsion which thus reaches its maximum of sensitiveness after standing for some hours in a cool place. With this method it is not advisable to seek to hasten the ripening by employing heat.

Choice of Soluble Bromides.—The bromides of ammonium and potassium are the ones most commonly employed in the manufacture of gelatine emulsions. There is little choice between them. Emulsions prepared with one show little or no difference from those prepared with the other. On this point Eder says that potassium bromide, owing to its stability, appears more suitable than the hygroscopic ammonium salt, which discolors under the action of light. Some operators use a mixture of the two salts, claiming superior results, a claim which numerous experiments of my own have failed to substantiate. Either of the two salts may be employed without necessarily prejudicing the quality of the resulting emulsion.

In substituting one salt for the other it must be remembered that their combining weights are different, as shown in the following table; the combining weight of the potassium bromide is 119, that of the ammonium is 98; hence one part of the former may replace 0·823 of the latter, or one part of the ammonium bromide may be replaced by 1·214 of the potassium salt.

The principal bromides, chlorides, and iodides which are likely to be used in emulsions of either gelatine or collodion have been included in these tables. Table No. I. presents to the reader, without any mystification which may be involved in equivalents, the actual weights of haloid or silver, as the case may be, required to convert or combine with one grain of the other.

Tables for the Simplification of Emulsion Calculations.

No I.

	Equivalent weights.	Weight of $AgNO_3$ required to convert one grain of soluble haloid.	Weight of soluble haloid required to convert one grain $AgNO_3$.	Weight of *silver* haloid produced by one grain of *soluble* haloid.	Weight of *soluble* haloid required to produce one grain of *silver* haloid.	Weight of silver haloid produced from one grain $AgNO_3$.
Ammonium bromide.	98	1·734	·576	1·918	·521	
Potassium bromide	119·1	1·427	·700	1·578	·633	
Sodium bromide	103	1·650	·606	1·825	·548	
Cadmium bromide, com.	172	·988	1·012	1·093	·915	1·106
Cadmium bromide, anh.	136	1·25	·800	1·382	·723	
Zinc bromide	112·1	1·509	·663	1·670	·600	
Ammonium chloride	53·5	3·177	·315	2·682	·373	
Sodium chloride	58.5	2·906	·344	2·453	·408	·844
Ammonium iodide	145	1·172	·853	1·620	·617	
Potassium iodide	166·1	1·023	·977	1·415	·707	
Sodium iodide	150	1·133	·882	1·566	·638	1·382
Cadmium iodide	183	·929	1·076	1·284	·778	

In order to test the utility of this table, let us suppose that it is desired to make (say) ten ounces of emulsion by a new formula, which, for the sake of showing the working of the table, we write down as follows:

Bromide of potassium ..... 150 grains
Iodide of Potassium ..... 10 grains
Chloride of ammonium ..... 10 grains
Gelatine ..... 200 grains

Now we want to know how much silver nitrate should be employed in sensitizing this mixture. For this purpose we use the first column, in which we find against each haloid the exact quantity of silver nitrate required to fully decompose one grain. Taking, then, the figures we find in column No. 1 against the three salts in the above formula, and multiplying them by the number of grains of each used, we have the following sum:

Potassium bromide ..... 150 × 1·427 = 214
Potassium iodide ..... 10 × 1·023 = 10·23
Chloride of ammonium ... 10 × 3·177 = 31·77
} Weight silver nitrate required.

or the total quantity of silver nitrate required for full conversion, 256·00 grains.

No. II.

	Ammonium Bromide.	Potassium Bromide.	Sodium Bromide.	Cadmium Bromide. (Coml.)	Cadmium Bromide. (Anhyd.)	Zinc Bromide.	Ammonium Chloride.	Sodium Chloride.	Ammonium Iodide.	Potassium Iodide.	Sodium. Iodide.	Cadmium Iodide.
Ammonium bromide	1	·823	·951	·57	·72	·87	1·832	1·675	·676	·59	·653	·535
Potassium bromide	1·215	1	1·156	·692	·876	1·058	2·226	2·036	·821	·717	·794	·651
Sodium bromide	1·051	·865	1	·599	·757	·915	1·925	1·761	·71	·62	·686	·563
Cadmium bromide, com.	1·755	1·444	1·67	1	1·265	1·527	3·215	2·94	1·186	1·035	1·146	·94
Cadmium bromide, anh.	1·387	1·141	1·32	·79	1	1·207	2·542	2·324	·938	·819	·906	·743
Zinc bromide	1·149	·945	1·093	·655	·828	1	2·104	1·925	·776	·678	·75	·615
Ammonium chloride	·546	·449	·519	·311	·393	·475	1	·914	·369	·322	·356	·292
Sodium chloride	·597	·491	·568	·34	·43	·519	1·093	1	·403	·352	·39	·319
Ammonium iodide	1·479	1·217	1·408	·843	1·066	1·287	2·712	2·478	1	·873	·966	·792
Potassium iodide	1·695	1·394	1·612	9·65	1·221	1·475	3·104	2·839	1·145	1	1·107	·907
Sodium iodide	1·53	1·259	1·456	8·72	1·103	1·332	2·803	2·564	1·034	·903	1	·819
Cadmium iodide	1·867	1·536	1·776	1·064	1·345	1·625	3·42	3·128	1·262	1·102	1·22	1

Table No. II. gives in separate columns the relative converting values of each of the soluble haloid salts in ordinary use, showing how much of any salt must be used to replace one grain of any other. In each column will be found an unit (printed in larger type) which represents one grain of the salt named at the head of the column ; the other figures in the same column show the exact quantities of the other salts which must be used in lieu of a single grain of that particular haloid. Thus, taking the first column, which is headed "Ammonium Bromide," we find against ammonium bromide in the margin the figure 1, representing one grain of that salt. If we wish to know the relative converting power of potassium bromide we take the number in the same column which stands against the latter salt in the margin, viz., 1·215 ; that is to say, 1·215 grain of potassium bromide will be required to do the same work as one of NH_4 Br.

Choice and Treatment of the Gelatine.—The gelatine employed must have been prepared especially for photographic purposes, and a supply both of the hard and the soft varieties should be kept on hand. An emulsion prepared with a mixture of both hard and soft gelatines gives better films than one in which either the hard or the soft alone was used. In winter, equal proportions of the two should be used; in summer, the proportion of the hard variety should be increased to two-thirds of the total amount employed.

The gelatines manufactured by Cox, Nelson, Coignet, Heinrich or Simeon will be found the best. Even when the best gelatines are employed, the operator will often be troubled with grease spots in his films; to avoid this danger the author recommends that the gelatine solution be purified in one of the following ways:

To each thirty-five ounces of gelatine solution add the white of one egg beaten to a froth. Mix well and boil for fifteen minutes in a water bath. The albumen, coagulated by the heat, frees the gelatine from all impurities. When cooled down to 100 deg. the liquid is filtered. This method removes all danger from grease spots, but when the nitrate of silver is added to a gelatine solution thus treated, a precipitate is formed which

must be removed by decantation. Another equally good method is to soak the gelatine, cut up in shreads, for an hour in a one per cent. potassium bromide solution, and then wash in three or four changes of water. Excess of water is then removed by squeezing the gelatine wrapped in a piece of clean muslin. The mass is then weighed, and the difference in weight between the dry and the wet gelatine is deducted from the amount of water directed to be added to form the emulsion. It is well to test the gelation solution with litmus paper. If it shows an acid reaction, neutralize with ammonia; if alkaline, neutralize with a few drops of a ten per cent. nitric acid solution. In this case do not add the acid indicated in the formulæ.

Proportion of the Ingredients.—Great diversity exists in the proportions used of the various ingredients used in making an emulsion. The following table gives an average computed from the comparison of many formulæ.

Water	1 ounce
Bromide of ammonium	15 to 20 grains
or,	
Bromide of potassium	18 to 25 grains
Nitrate of silver, proportioned to the amount of bromide	25 to 30 grains
Gelatine	30 to 40 grains

The proportion of gelatine varies according to its nature and the temperature. In summer more, in winter less.

The amount of emulsion required to coat the plates is not constant; from four to five drams for a whole plate is about right.

Emulsifying.—To dissolve the gelatine and to make the emulsion, it is best to use a hot water-bath, and to place the emulsion in a clean glass or porcelain flask capable of withstanding heat and sudden changes of temperature. For experimental work on a small scale very simple arrangements will suffice; a tin pail, an old coffee pot, or any similar vessel with a tightly fitting cover, will answer for the water bath, and the emulsion may be placed in a stout bottle, a porcelain capsule, or a Bohemian glass of suitable shape and size. But for

more ambitious attempts something more elaborate must be devised. The writer knows of nothing better than one of the two arrangements figured and described below. The first, shown in Fig. 18, is a somewhat elaborate emulsifying apparatus recommended by David and Scolik, and is well adapted for work on a large scale.

Fig. 19 shows the apparatus devised by M. Davanne, and it is the best with which the writer has experimented, as it combines in itself all the requirements of emulsifying, filtering and washing.

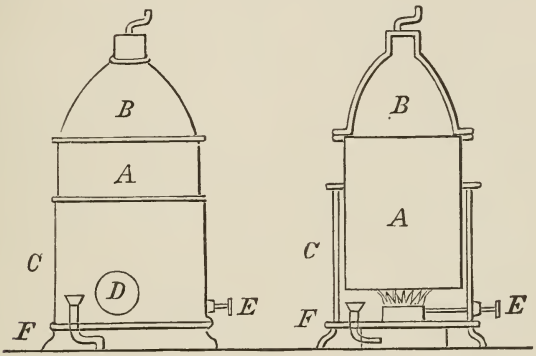

Fig. 18.

The essential parts of this apparatus consist of the lamp, F, the sheet-iron covering, A, and the cover, B. The lamp can be filled and the flame regulated from the outside as shown in the cut. D is a small window of ruby glass through which the flame can be seen. A is the water-bath in which the vessel containing the emulsion is placed. It is provided with a double bottom. B is the cover, closed at the top with a small bent pipe soldered in to allow the steam to escape. This cover must fit light-tight over A. This is easily effected by soldering a small gutter-shaped trough around the top of A, into which the bottom of B fits. By filling this trough with small shot a light-tight joint is made.

The dimensions of the various parts will depend upon the quantity of emulsion to be cooked. I have had no experience with this apparatus, but it is theoretically good, and should

work well if properly constructed. A very good substitute for it is found in the infants' food-warmer, to be had of most druggists, which consists essentially of a covered porcelain jar resting in a metallic water-bath, the water in which is heated by means of a candle placed underneath.

Fig. 19 illustrates M. Davanne's ingenious apparatus.

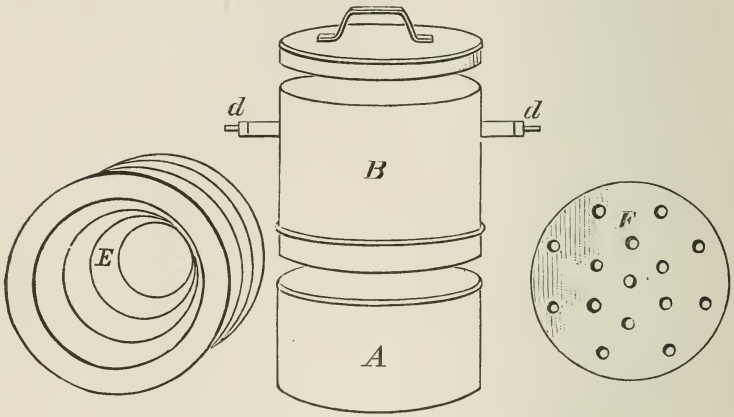

Fig. 19.

It is simply a common steam cooker somewhat modified to adapt it to its new use. A is the hot water receptacle; B, fitting tightly over A, contains the vessel in which the emulsion is placed; d, d, are two small tin tubes soldered into B, which serve to convert the apparatus into a convenient washing arrangement. To construct the apparatus the perforated bottom is removed from B, leaving a margin of one-quarter of an inch around B to receive the movable plates used in the different operations. The portion removed is used as a false bottom in A to prevent breakage of the various flasks which may be placed there. Its place in B is filled by a movable plate, F, pierced with holes. On this plate all the preparations are placed which are to be heated with steam instead of warm water.

Three or four other metal plates are provided, of the form shown at E, with various sized openings. These are intended to

hold funnels for warm filtration, or flasks containing solutions, the temperature of which requires careful watching.

The following description will demonstrate the great adaptability of this simple piece of apparatus:

Cooking the Emulsion.—The flask containing the emulsion is placed on the false bottom, the cover is put on and the tubes d, d, closed with corks, and the water brought to the proper temperature; or the flask is placed on the perforated bottom of B, and the emulsion cooked by steam.

Filtering.—The filter is placed in one of the metallic plates, E, in such a way that it is nearly introduced into B, a flask is placed beneath it, and the water is heated; the heat thus produced is sufficient to prevent the emulsion from closing the pores of the filtering medium.

Washing.—The shredded emulsion is placed in a wide-mouthed flask fitted with a cork, through which pass two glass tubes, one reaching nearly to the botton, the other only a few inches; the tubes d, d, are closed with corks carrying glass tubes which are connected with the tubes in the flask by means of black india-rubber piping. The tube thus attached to the longer tube in the flask is connected with the tap by rubber piping. The writer confidently recommends this apparatus to all experimenters as a most convenient and compact arrangement.

Filtration.—All emulsions must be filtered before the plates are coated. To effect this in the case of emulsions containing gum or gelatine, it is often necessary to resort to the method of warm filtration to prevent the pores of the filtering medium from being closed. Small quantities of emulsion are easily filtered through a clean lamp chimney, around the top of which two or three thickness of clean linen have been tied. Another good method, as it avoids air bubbles, is the method of upward filtration already described.

For large quantities of emulsion, however, some means of keeping the emulsion warm during the process of filtration must be resorted to. Figs. 12 and 13 (page 19) illustrate two very efficient arrangements for warm filtration. There is little choice between them, both being constructed on the

same principle. To avoid air bubbles, it is well to bring the tube of the funnel in contact with the side of the vessel into which the emulsion is to be filtered.

If Davanne's apparatus is used, neither of these latter will be needed.

Silvering.—In order to produce the bromide of silver in the extremely fine state of division necessary to give good results, it is imperative that the nitrate solution be added slowly to the emulsion. A simple means of effecting this is to add the silver in small quantities, and to shake well after each addition. Another, and perhaps a better, is to pour the silver solution into the emulsion in a fine stream with constant stirring. A good stirrer is made by fastening a strip of glass across the end of a glass rod with a piece of clean twine. A rotary motion is imparted to the rod by twirling it between the thumb and forefinger.

An ordinary glass funnel is easily adapted for silvering purposes, by inserting a clean cork in the lower end of the tube and boring a small hole through it.

A spray apparatus is also very efficient for this purpose. Fig. 20 shows a form which is easily constructed.

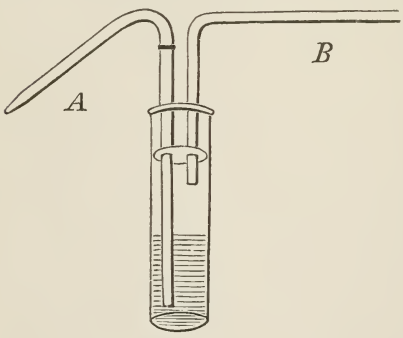

Fig. 20.

Two thin glass tubes are bent in the shapes shown at A and B. The tube, A, is drawn to close the bore. A flat file is then used to file away the point, leaving a very small orifice. The two tubes are then fitted into a cork which is placed in a test tube, as shown in the figure. The silver nitrate is placed in the test tube, the cork inserted, and a fine spray of liquid is forced out by blowing through the tube, B. The handiness of the apparatus is increased by adapting to B, with a piece of rubber tubing, a rubber ball provided with a valve.

The silvering apparatus shown in Fig. 17 is also very efficient.

Digesting the Emulsion.—The vessel containing the emulsion is placed in the water-bath, which is brought to the required temperature. If the emulsion is to be boiled, a bent glass tube should be inserted in the cork which closes the flask.

Breaking Up and Washing.—After digesting the proper length of time, the emulsion is allowed to set, by pouring it out into a clean shallow tray. When well set it is cut up into narrow strips with a clean ivory paper cutter; the strips are then placed in the center of a square of working canvas, previously soaked in a solution of carbonate of soda and well washed, and squeezed out into a deep dish full of clean water. The washing can be done in a variety of ways. The simplest is to wash in many changes of water, stirring the emulsion well after each change, and allowing it to settle before decanting the water. If this method be adopted a double tubed decantation flask will be found very convenient; a piece of clean muslin is tied over the small tube and the emulsion introduced through the large one. It is well to squeeze the emulsion through the canvas once more when half washed. A half hour's washing in this way will probably eliminate all the soluble salts.

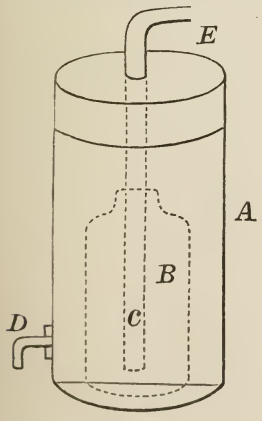

FIG. 21.

Capt. Abney has recommended the following very simple washing apparatus, the use of which makes it possible to wash the emulsion in full daylight. Fig. 21 makes its construction sufficiently evident. A hole is perforated in the lid of a tin canister of sufficient size to admit a glass tube, C. This tube is connected with the water-tap by a piece of well-washed black india rubber piping. A spout, D, is soldered to the canister. To prevent the emulsion from being carried over the top of the flask, a piece of muslin is tied over its mouth around the glass tube.

The method of converting Davanne's cooker into a washing apparatus has already been given.

When the washing is nearly completed a small quantity of the wash-water is placed in a glass and a few drops of a neutral solution of nitrate of silver are poured in. If the mixture examined by white light shows no coloration the washing is sufficient.

Draining.—When the emulsion is sufficiently washed it is drained to remove the excess of water. A hair-sieve may be used for this purpose, or a piece of linen or open-meshed canvas tied over the top of a large earthen vessel. The emulsion should be allowed to drain two hours. At the end of that time it will be well to pour a few ounces of alcohol over the mass.

Re-melting.—The emulsion is re-melted in the water-bath at a low temperature; during this process the emulsion should be stirred occasionally. When dissolved it is ready for filtering.

Formulæ for Emulsions.

Audra's.—Weigh out the following:

Bromide of ammonium	138 grains
Nitrate of silver	208 grains
Gelatine	310 grains

Dissolve the ammonium salt in five ounces of water, and add 138 grains of the gelatine cut up into shreds. As soon as the gelatine has swelled, dissolve in the water-bath.

While this is taking place, dissolve the silver in two and a half ounces of water, with gentle heat. While both solutions are warm, add the silver solution to the gelatine by any of the methods indicated above. This and the following operations must be carried out by ruby light.

The silvered emulsion is to be kept at the boiling point for thirty minutes, or until a few drops of it, spread on a strip of glass, is blue by transmitted light. Allow it to cool down to about 120 deg. and then add eighty-one grains of shredded gelatine previously swelled in cold water. When the gelatine is dissolved add two drams of a two per cent. bichromate of potash solution; mix well, and pour out into a clean porcelain tray to set. When set the emulsion is cut into shreds,

squeezed through canvas, and washed. It is then drained, eighty-one grains of swollen gelatine added and dissolved by gentle heat, and poured out as before to set. When the emulsion is set it is covered with alcohol and allowed to ripen for eight days. It is then melted, filtered, and spread over the plates.

Henderson's Ammonia Method.—

In

Distilled water.....8⅓ ounces

dissolve

Bromide of ammonium.....308 grains
Gelatine (previously swelled) ..... 50 grains

When cold add

Water.....1¾ ounces
Alcohol.....1¾ ounces
Strong ammonia..... .....4 drams

In

Distilled water.....3½ ounces

dissolve by heat

Nitrate of silver.....462 grains

and add gradually to the first solution.

An emulsion thus prepared lacks sensitiveness. This is produced by allowing the emulsion to ripen for twenty-four hours; under the alkaline conditions present sensitiveness is conferred in this simple way. At the end of twenty-four hours 220 grains of swelled gelatine are added and dissolved by gentle heat. Then proceed as above.

Eder's Ammonio-Nitrate of Silver Method.—

In

Distilled water..... 4 ounces

dissolve

Bromide of potassium.....310 grains

add

Gelatine.....617 grains

previously swelled in water.

In

Distilled water..... .....4 ounces

dissolve

Nitrate of silver .....462 grains

To this solution, cold, add strong ammonia, drop by drop, until the precipitate first formed is re-dissolved.

Add this gradually to the first solution, and place in a water-bath at a temperature of 105 deg. Remove the source of heat and allow the emulsion to cool down gradually to about 75 deg., then pour out to set, and proceed as usual. For plates of moderate sensitiveness the author prefers this method to any others with which he has experimented.

Braun's Method.—

In

Distilled water.....4 drams

dissolve

Bromide of ammonium.....964 grains

add

Gelatine.....92 grains

previously swelled in

Distilled water.....19 ounces

dissolve

Nitrate of silver.....1,543 grains

and add to the first solution ; after a few minutes add

Strong ammonia.....12 drams

and stir well.

For plates of medium rapidity digest for six hours at a temperature of 95 deg. When great sensitiveness is desired digest for twelve hours at the same temperature.

As soon as the digestion is finished, turn the emulsion out into a three-gallon earthen jar containing half a gallon of distilled water. Put on the cover and allow it to stand for four days if it was digested for twelve hours, and six days if digested six hours. By this time all the sensitive bromide of silver will have deposited. The water is then decanted and 1,235 grains of gelatine, swelled in 39 ounces of water, are added to the bromide, and well stirred. The mixture is melted at a temperature of 105 deg. As soon as the gelatine is dissolved, the emulsion is filtered and used for coating the plates.

This method gives clean plates, which yield crisp, brilliant negatives, of great clearness in the shadows.

Scolik's Ammonio-Nitrate of Silver Method.—

In

Distilled water.....17½ drams

dissolve

Bromide of ammonium.....308 grains
Bromide of potassium.....370 grains

and add

Iodide of potassium solution (1 to 10).....2 to 3 drams
Hard gelatine.....704 grains } in winter
Soft gelatine.....704 grains }

or,

Hard gelatine.....1,003 grains } in summer
Soft gelatine.....400 grains }

Allow the gelatine to soak for half an hour in

Distilled water.....17½ drams

dissolve

Nitrate of silver.....926 grains

Add ammonia, drop by drop, to re-dissolve the precipitate first formed, stirring well.

Dissolve the gelatine in the water-bath at a temperature of 150 deg. Then, in the dark room, add the silver solution in a fine stream, with constant stirring. Replace the emulsion in the water-bath for half an hour, the source of heat being withdrawn. At the expiration of this time the emulsion is poured out to set.

Scolik's Modification of Henderson's Cold Emulsion Method.—

In

Distilled water.....38 drams

dissolve at 120 deg.

Soft gelatine.....45 to 60 grains

add

Citric acid.....15 grains

when dissolved add

Carbonate of ammonia.....108 grains
Bromide of ammonium.....694 grains
Iodide of potassium solution (1 to 10).....2 drams

When these salts are dissolved add a mixture of

Alcohol.....13 ounces
Ammonia..... 4½ drams

In

Distilled water.....9¾ ounces

dissolve

Nitrate of silver .....925 grains

Add this to the bromized solution as usual, cork the flask tightly to prevent the escape of ammonia fumes, and set aside for twenty-four hours to ripen. Then add 1,000 grains of soft, and 300 grains of hard gelatine, and dissolve at a temperature of 95 deg. Set, wash, and filter as usual.

Davanne's Method.—

In

Distilled water.....12½ ounces

swell, dissolve, and filter

Soft gelatine.....925 grains

In

Distilled water.....5½ ounces

dissolve

Bromide of ammonium.....262 grains

add

Gelatine solution.....3½ ounces

In

Distilled water.....5½ ounces

dissolve at 85 deg.

Nitrate of silver.....416 grains

and add to the bromized solution as usual.

This gives an excellent slow emulsion, with the addition of 3½ ounces of the gelatine solution. To increase sensitiveness boil for half an hour, and then add

Gelatine solution .....3½ ounces
Bichromate of potassium solution (2 per cent.)....3 drams

Burton's Precipitation Method.—

In

Distilled water..... 1½ ounces

dissolve

Bromide of ammonium.....120 grains
Iodide of ammonium..... 10 grains

Add

Soft gelatine..... 30 grains

swell and dissolve at 95 deg., and add

Hydrobromic acid..... 1 drop

In

Distilled water..... 1½ ounces

dissolve

Nitrate of silver.....212 grains

and add to the bromized solution in a fine stream.

Boil for thirty minutes; cool down quickly to about 60 deg., and then pour the emulsion in a fine stream into a clean dish containing eight ounces of alcohol. In a few seconds the emulsion precipitates; it is then washed by decantation in a few changes of water, after which it is added to the following solution:

Soft gelatine.....120 grains
Hard gelatine.....150 grains
Distilled water..... 12 ounces

The mixture is well shaken to effect solution; the emulsion is then filtered and used for coating.

This method has many points to recommend it. The plates are of the best quality, and yield plucky negatives. The bromide of silver precipitate may be prepared, dried and preserved indefinitely, and the tedious operations of prolonged washing and draining are done away with, since a few changes of water serve to eliminate the last traces of the soluble salts from the precipitated bromide.

Fabre's Method.—By this method the sensitive bromide of silver is produced directly by macerating in a mortar the proper proportions of bromide of silver and sulphate of potash. By the addition of a few drops of distilled water, long, needle-like

crystals are formed; the addition of a slight excess of water destroys this combination and produces the sensitive modification of bromide of silver, which may then be emulsified with gelatine as usual.

This method does away with washing, draining, and the use of alcohol; and some few experiments made with emulsions so prepared indicate remarkably fine qualities in the plates. To form the sensitive salts, mix intimately in a mortar one part of bromide of silver and two and one-fourth parts of sulphate of potash; then add of distilled water, drop by drop, not more than one-tenth of the weight of the bromide. The first combination is formed within five minutes. A slight excess of water is then added; this destroys the former combination and forms the sensitive salt, which, after two or three washings, may be dried and preserved for future use, or incorporated immediately with a gelatine solution. The emulsion is made up as follows:

Distilled water	3½ ounces
Sensitive bromide	77 grains
Gelatine	45 to 75 grains

Boil till a trial film is blue by reflected light.

Some operators prefer to add the nitrate of silver to the bromized solution in large crystals.

The following formulæ and explanations are given to illustrate this method, which gives results equal to the best.

In

Distilled water	5 ounces

dissolve

Bromide of potassium	164 grains
Iodide of potassium	20 grains

Add

Soft gelatine	80 grains

Allow the gelatine to soak for fifteen minutes, and then dissolve at 120 deg.

In a strong bottle place

Nitrate of silver	232 grains

Heat both vessels to 140 deg., then add the crystals of silver to the bromized gelatine and shake vigorously till the silver is

dissolved. Boil for thirty minutes, then cool down to 100 degrees.

Add

Hard gelatine.....180 grains
Soft gelatine.....100 grains
Water.....to cover.

Soak fifteen minutes.

Stir well until the gelatine is dissolved, and add

Strong ammonia.....1 dram

and stir vigorously. Pour out to set.

Burton's Method for a Very Slow Emulsion.—

In

Distilled water ..... 3 ounces

dissolve

Bromide of potassium .....160 grains
Iodide of potassium..... 10 grains
Soft gelatine..... 40 grains

Soak the gelatine for fifteen minutes before dissolving; when dissolved, add

Hydrochloric acid.....2 drops

In

Distilled water .....3 ounces

dissolve

Nitrate of silver..... .....200 grains

Heat both solutions to 120 deg., and add the nitrate gradually to the gelatine with constant stirring.

After ten minutes, pour the emulsion over

Hard gelatine..... .....150 grains

previously swelled in cold water and all excess of water removed by pressing in a cloth. Heat until dissolved, and set aside to set. Then break up, wash, and add

Hard gelatine.....150 grains

treated as before. Melt, and add

Alcohol..... .....4 drams

Filter and coat.

Gelatino-Chloride Emulsion for Slides and Transparencies.—

In

Distilled water .....7 ounces

dissolve

Chloride of sodium. .....108 grains
Gelatine .....310 grains

In

Distilled water.....3½ ounces

dissolve

Nitrate of silver.....231 grains

Heat both solutions to 120 deg., and add the nitrate to the gelatine.

Pour out to set at once.

Wellington's Citro-Chloride Emulsion for Opals.—

In

Distilled water.....3 ounces

dissolve

Chloride of sodium ..... 20 grains
Bromide of potassium..... ..... 40 grains
Citric acid.....100 grains
Soft gelatine..... 40 grains

In

Distilled water ....3 ounces

dissolve

Nitrate of silver.....100 grains
Citric acid ....100 grains

Heat both solutions to 150 deg., and add the nitrate to the gelatine.

Then add

Hard gelatine (swelled) .....200 grains

and stir until dissolved. Then pour out to set.

These plates are best developed with the ferrous oxalate developer, modified with chloride of ammonium and citric acid, as described in the chapter devoted to development.

Szekely's Process with Carbonate of Silver.—

The following solutions are made up:

1.—In

Distilled water.....45 drams

dissolve

Nitrate of silver.....261 grains

2.—In

Distilled water.....45 drams

dissolve

Bicarbonate of soda.....154 grains

3.—In

Distilled water.....45 drams

dissolve

Bromide of ammonium.....154 grains
Gelatine.....340 grains

Solution No. 2 is boiled, and then added to No. 1. The precipitate of carbonate of silver thus formed is well washed and thrown on a filter. When the bulk of the liquid has run through, the wet precipitate is placed in a beaker and its bulk made up, if necessary, to 45 drams. Strong ammonia is then added, until a clear solution is obtained.

This solution is poured gradually and with constant stirring into solution No. 3. The bottle is rinsed out with 5 drams of distilled water, which is added to the emulsion, which is then filtered into the funnel, from which it runs in a fine stream. The emulsion must be kept constantly stirred.

Sensitiveness is given to the emulsion by digesting it from one to two hours at a temperature of 100 deg.

All of the operations preceding the addition of the silver solution to the bromized gelatine may be performed in diffused white light.

The author finds that this process gives negatives rich in detail and gradation, and free from fog.

While the above formulæ are very far from exhausting the long list of gelatine emulsion formulæ, they are sufficient to meet all the possible needs of the photographer, and with proper precautions they are all reliable, and have stood the

test of practical experience. The writer's aim has been to give one typical formula of each class, and he has selected those which his own experience has proved to be best adapted to the special class of work for which they were designed.

Collodio-Gelatine Emulsions.—The great drawback to the preparation, in small quantities, of gelatino-bromide plates by amateurs has been the somewhat difficult operation of coating, and the need of efficient drying arrangements.

To obviate these difficulties many experiments have been made to produce emulsions combining the rapidity of the ordinary gelatine emulsion with the ease of coating of collodion. The aim of most of these experiments has been to combine pyroxyline with the gelatine emulsion. Under the usual conditions this is impossible, since the solvents of pyroxyline precipitate gelatine from an aqueous solution.

To Dr. H. W. Vogel belongs the credit of being the first to overcome this difficulty, and to produce a combined emulsion easy to coat with, and of good working qualities.

His method is to prepare a gelatine emulsion as usual, and after washing to dry it by spreading it out on clean blotting-paper where it is allowed to dry spontaneously.

The dried pellicle is dissolved by heat in three to ten times its weight of acetic acid, the quantity of acid varying according to the kind of gelatine used in making the emulsion. Enough alcohol is then added to make it flow well at a temperature of 90 deg.

Plates may be coated with the emulsion in this condition, but, in order to give greater tenacity, Dr. Vogel recommends the addition of an equal quantity of a collodion made as follows:

Pyroxyline	20 grains
Glacial acetic acid	1 ounce
Alcohol	1 ounce

Another method recommended by Dr. Vogel is to prepare a collodion emulsion, any of those described in Chapter VII. will answer. This emulsion is washed and dried. Seventy grains of the pellicle are dissolved in three ounces of alcohol and one and three-quarter ounces of acetic acid. Twenty

grains of plain gelatine are dissolved in three and a half drams of acetic acid and added to it. The emulsion is then ready for coating.

Kosarzewnki's Method.

Alcohol	2 ounces
Glacial acetic acid	2 ounces
Pyroxyline	18 grains

One hundred and eighty grains of gelatine emulsion are added and dissolved by heat.

Plates which are to be coated with any of these emulsions must first receive a very tenacious substratum, the albumen and silicate of soda substratum answers well.

The emulsion is flowed over the plates like collodion, the plates are drained, and then rocked gently to prevent the formation of ridges.

These plates may be developed by any of the methods described in Chapter XI.

The great advantage of this form of emulsion is that it may be kept in a bottle and used for coating plates as wanted.

Sensitiveness seems to be a trifle diminished, but the plates yield good results.

CHAPTER X.

COATING THE PLATES.

The Levelling Shelf.—Some means must be provided in the coating-room for keeping the plates perfectly level while setting. The most common practice is to use a glass, stone, or marble slab of suitable size. This is levelled by means of thin hard-wood wedges, or by levelling screws of the form shown in Fig. 22. The top screws into the base. By providing a supply of these, and a number of plate-glass slabs, a large number of plates may be placed to set on these slabs levelled one above the other, and left to dry in the coating-room, which must be light-tight, well ventilated, and free from dust. This method does away with drying-boxes, which are apt to be somewhat uncertain and irregular in their action.

To prevent the troublesome sticking of the plates to the levelling-shelf, owing to the spreading of the emulsion on the back of the plate, the writer has found it useful to cover the warmed and levelled slab with a plain gelatine solution, made insoluble by the addition of chrome alum, and then to sprinkle fine shot evenly over the coated surface.

The best results are secured when plates coated with an emulsion rich in gelatine are rapidly set. In warm weather, however, the films set slowly, and to hasten the process Prof. Burton has devised the cooling arrangement shown in Fig. 23. C is a tin or zinc tank, somewhat wider and longer than the levelling slab, A. It is fastened securely to the wall, and, when plates are to be coated, it is filled with ice. A faucet is inserted into one end to draw off the water.

Some coaters use a small tripod on which the plate to be coated is placed. Fig. 24 shows a simple form which can be levelled by means of the thumb-screws as shown.

The writer has used with success, instead of the customary levelling slab, the arrangement shown in Fig. 25.

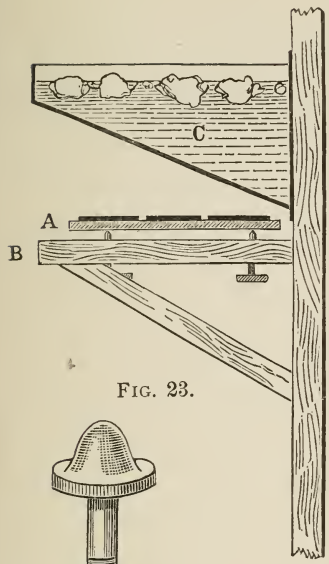

FIG. 23.

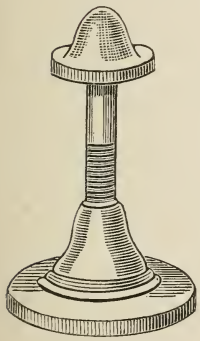

FIG. 22.

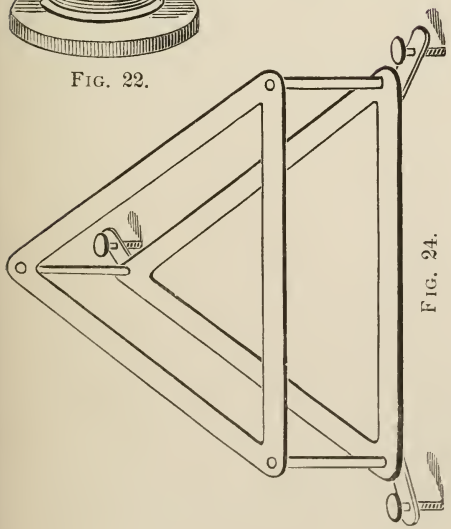

FIG. 24.

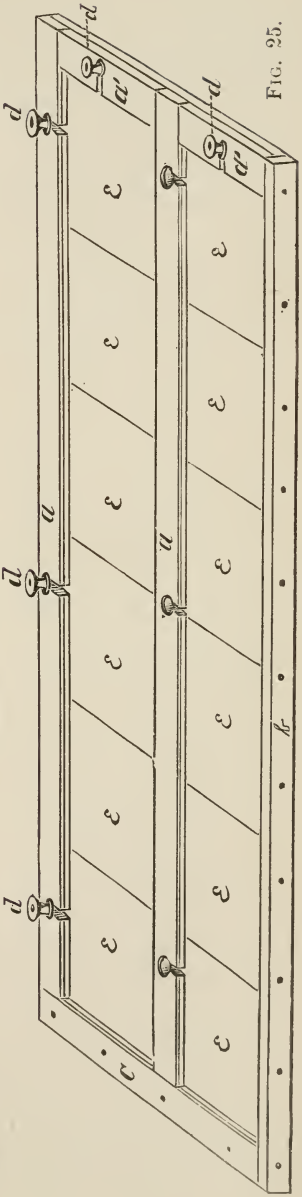

FIG. 25.

The purpose of this apparatus is to hold the plates firmly clamped end to end, and in connection with the coating-box, next to be described, to allow the plates to be rapidly and evenly coated without any of the emulsion running over the edges, as well as to avoid the necessity of disturbing the plates until the films are well set.

To construct the apparatus a hard-wood slab, of suitable length and width, and one inch thick, is smoothly and evenly planed, both surfaces being left perfectly plane and parallel. On the accuracy with which this is done depends the efficiency of the arrangement. Along one side a hard-wood strip, B, one and a quarter inches wide and a half-inch thick is firmly screwed. At one end a quarter-inch strip, half-inch wide is fastened. Two long strips, A A, of the same thickness, but two inches wide, and two short strips of equal width and thickness are next worked out of hard wood. The outer long strip and the two short ones are slotted to receive the thumb-screws, D, D, shown in the cut. These thumb-screws pass through the slots into the slab. The long strip in the center is also slotted and held loosely in place with common screws, or with thumb-screws if preferred. The inside edges of all these strips may be bevelled slightly towards the slab, although this is not essential. The slab should be battened at the ends to prevent warping. It should also be smoothly sand-papered and shellacked, as also the strips. The dimensions of the slab will vary with the size and number of the plates to be placed on it. That shown in the cut, designed to hold twelve whole plates in two rows, is 54 inches long and 17 inches wide. The slab is levelled by means of the screws shown in Fig. 22.

The plates, E, E, E, are placed on the slab between the strips as shown, the movable side and end pieces are pushed firmly against the plates, and thumb-screws tightened. The plates are then coated, using the coating-box shown in Fig. 26, and allowed to set. When set they may be removed by loosening the thumb-screws and taking away the movable strips, as the slots are cut through to the inside edges.

If a number of these slabs are provided, one can be levelled above the other, and a large number of plates coated in a short

time. This arrangement when used in connection with the coating-box has but one disadvantage—that of slow setting. This may be obviated by placing between the strips long strips of plate-glass, slightly narrower and shorter than the width and length of the plates. In this case the thickness of the movable strips must be increased.

Coating-Box.—A very efficient coater is shown in Fig. 26.

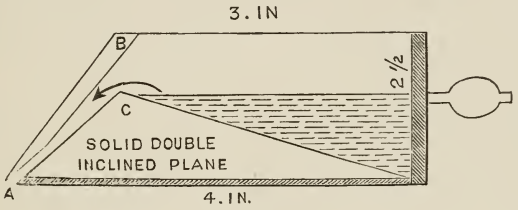

FIG. 26.

The box is exactly 6½ inches wide, for coating whole plates. C is a solid double inclined plane. The outlet, A, is made by inserting a piece of cardboard between B and C, while the box is being fastened together. A piece of cloth is glued over this opening. The box is made of wood firmly fastened with glue and screws, and well shellacked outside and in. The emulsion is poured in, and made to run over the inclined plane by tilting the box.

Other Methods of Coating.—Plates up to 6½ by 8½ inches are easily coated by balancing the plate on the thumb and fingers of the left hand, then with the right hand pour carefully over the plate the exact quantity of emulsion necessary to give a film of the desired thickness. The spreading of the emulsion may be helped by using a glass rod, a clean camel's-hair brush, or the tip of the little finger. The plate is gently rocked a moment to equalize the film and then placed on the levelling slab to set.

The flowing of the emulsion will be greatly helped by first passing over the surface of the plate a squeegee muffled in soft flannel and moistened in warm water.

When the plates have received a substratum of water glass, or one of sugar, the emulsion can be flowed over the plate like collodion.

Some operators prefer to coat the plates while resting on the levelling tripod shown in Fig. 24, but the author sees no advantage in this practice.

Another method is to level the plate, then to pour on the necessary quantity of emulsion which is equalized with a broad camel's-hair brush used for this purpose only. The brush is rapidly drawn over the surface of the plate in all directions to secure an even coating. Brushes used for this purpose should have rubber mountings, if those mounted in metal be used, the metal must be well shellacked. This is a simple and expeditious method.

In whatever way the coating is done, the plates must be slightly warmed and dusted before the emulsion is poured on.

Quantity of Emulsion Necessary to Cover Various Sizes of Plates.—The film when dry must have a certain thickness in order to give sufficient density to the image. The only test possible in the coating-room is to examine the films when set, by transmitted light. If the outline of the flame of the ruby lamp can be just made out through the film, the coating is all right. To secure this result it is best to cover each plate with a fixed and constant quantity of emulsion, using a pipette, or a horn or wooden spoon of proper size for each size of plate.

The following table gives the quantities of emulsion necessary to give a good film to the sizes in most common use:

3¼ by 4¼ inches	1 dram
4 by 5 inches	1½ drams
4¼ by 6½ inches	2 to 3 drams
5 by 8 inches	3 to 4 drams
6½ by 8½ inches	4 to 5 drams
8 by 10 inches	6 to 8 drams

One dram of emulsion for every ten square inches of surface is about right.

Drying.—When set the plates may be dried by any of the methods described in Chapter I.

Packing the Plates.—Many different methods of packing the prepared plates. The writer prefers to place them face to face in packages of half-a-dozen, well wrapped up in non-actinic paper, and to store them in pasteboard boxes, also well wrapped, in a cool, dry place.

CHAPTER XI.

DEVELOPMENT, FIXING, ETC.

The reader is referred to Chapter II. for the theory of development and fixing. What follows in this chapter deals with the practical manipulations of the dark-room.

Development.—Many substances possess the power of reducing salts of silver to the metallic state, and so giving visibility to the latent image impressed by the action of light. Among others, mention may be made of sulphate, borate, phosphate, and tartrate of iron, pyrogallic acid, hydrochinone, hydroxylamine, resorcin, and pyrocatechin. Of these the sulphate of iron, pyrogallic acid, and hydrochinone alone have more than an experimental value. Hydrochinone, although a powerful reducer, is but little used at present, owing to its high cost. The oxalate of iron and pyrogallic acid are the reducing agents now in most common use, each having its advocates and each its own place in photographic work.

The oxalate of iron developer is the simplest, the cleanliest, and the easiest to work, but as a rule it does not work well with short exposure; it does not admit of so wide a range of modification to correct errors of exposure as does the method with pyrogallic acid. On account of the regularity of its action, and the fact that it does not stain the film or the hands, it is perhaps the best method for beginners.

Pyrogallic acid is more powerful, has a wider range of modification to adapt it to the varying needs of the operator, and seems to give better modeling and a more perfect rendering of half tones. It is the method for the advanced practitioner, whose judgment has been ripened by long experience

Formulæ.

Oxalate of Iron Developers.

1.—Trutat's Formula.

a.	Neutral oxalate of potash	30	parts
	Water	100	parts
b.	Sulphate of iron	30	parts
	Tartaric acid	½	part
	Water	100	parts

Solution *b* will keep indefinitely if placed in a strong light when not in use.

c.	Bromide of potassium	5	parts
	Water	100	parts

This is the restrainer, and is to be used only in cases of over-exposure.

To make the developer add one part of *b* to three or four parts of *a*. If the plate proves to have been over-exposed, add ten drops of *c* to each ounce of developer. Develop until the image is visible at the back of the plate.

The proportions of one to three, given above, are the strongest possible with this form of developer, and for full exposures will prove too powerful. A safer method is to cover the plate first with a mixture of four parts of *b* and one hundred parts of *a*.

If the high lights begin to appear in one or two minutes, the exposure was about right, and the plate is removed to a second tray containing twelve parts of *b* to one hundred parts of *a*, in which the development is completed. If, however, the image is slow in appearing in the first solution, it is an evidence of a short exposure, and the plate is transferred to the second tray, and after a few moments to a third containing the normal developer—*b* twenty-five parts, *a* seventy-five parts. If even this strong developer does not bring out sufficient detail, pour the developer into a graduate containing a few drops of a very dilute solution of hyposulphite of soda (1 to 2,000), and return to the plate. The effect is almost instantaneous, a slight veil comes over the image, but new details appear. If too much of the accelerator be added the veiling becomes too pronounced and the plate is ruined. The addition of hypo is always dangerous.

2.—Eder's Concentrated Developer.

Neutral oxalate of potash.....2 ounces
Water.....6 drams
Sulphate of iron.....3½ ounces

Dissolve the oxalate in boiling water; when dissolved add the iron and keep at 200 deg. until dissolved. Set aside for twenty-four hours, then decant the clear liquid for use.

This forms a very powerful developer for instantaneous views, but should be diluted somewhat with water.

3.—Eder's Oxalate Developer.

a. Neutral oxalate of potassium.....100 parts
Distilled water.....400 parts

Acidulate with oxalic acid

b. Sulphate of iron..... 50 parts
Distilled water.....150 parts
Sulphuric acid..... 3 drops

c. Bromide of potassium..... 5 parts
Distilled water..... 50 parts

d. Hyposulphite of soda..... 1 part
Distilled water.....100 parts

For the developer take of *a* three parts, of *b* one part. Restrain with a few drops of *c*.

For over-exposures take less of *b*, adding more if required. To give density use *c*.

For soft, harmonious negatives full of detail take of

a.....2½ ounces
b..... ½ ounce
c.....4 drops
d.....6 drops

4.—Ferrous Oxalate Developer with Citric Acid for Intense (Black and White) Negatives.

a. Water.....500 parts
Sulphate of iron.....150 parts
Citric acid..... 2 parts

b. Water.....500 parts
Neutral oxalate of potassium.....200 parts

Solution *b* is boiled, and when cold filtered from the green crystals which may have separated out. One part of *a* is mixed with four parts of *b* to form the developer.

5.—Oxalate Developer with Chloride of Ammonium and Citric Acid for Wellington's Citro-Chloride Emulsion.

a. Oxalate of potassium..... ..... 2 ounces
Chloride of ammonium.....40 grains
Water.....20 ounces

b. Sulphate of iron..... ..... 4 drams
Citric acid.. .... 2 drams
Water.....20 ounces

c. Bromide of potassium.... ..... 1 ounce
Water..... ..... 3 ounces

Mix *a* and *b* in equal volumes, and add one dram of *c* to each ounce of developer.

Alkaline Development.—In all alkaline developers there are three elements: 1, pyrogallic acid, or its equivalent; 2, an alkali; 3, bromide of potassium or ammonium.

The process of development will be better understood if we consider the office which each of these elements fills in development. This will enable the operator to compound and modify his developing solutions to suit his tastes and needs.

Pyrogallic acid is a powerful absorbent of oxygen, and reduces the soluble salts of silver to the metallic state; it is then the reducing agent in most alkaline developers. Its place may be supplied by other oxygen absorbers, such as hydrochinone, hydroxylamine, etc.

Owing to its reducing power, due to its affinity for oxygen, pyrogallic acid gives density to the image. If the amount of alkali used remains constant, the density will be proportioned to the amount of acid used. The degree of density conferred is governed by the amount of pyro used, although an increase of the alkali may serve the same purpose.

The alkali, either ammonia or the carbonates of potash or soda, combines with the bromide, which is set free from the silver by the reducing power of the pyro. If the amount of alkali be increased, there is a corresponding increase of the affinity of pyro for oxygen, and in consequence a greater reducing action, giving an increased amount of reduced silver, which may increase density. Hence an increase of alkali means increased rapidity of development. If an excess of

alkali be added the reduction of silver takes place so rapidly as to produce fog.

Soft, harmonious images are produced by the use of a comparatively large proportion of alkali, the pyro being kept slightly under strength.

On the other hand an excess of pyro gives great density and heightens the contrasts between the tones of the image.

The bromide diminishes the affinity of pyro for oxygen, and hence acts as a restrainer. It also diminishes the liability of the pyro attacking the unaltered bromide of silver, and thus, to a certain extent, prevents fog.

The use of bromide is not always necessary, since gelatine itself acts as a restrainer, by holding the particles of silver enclosed in a semi-impervious coating, which presents more or less resistance to the action of the developer.

This brief explanation of the function of each of the components of an alkaline developer will, it is hoped, enable the operator to compound his developer with judgment, and to use it with discretion, modifying it by increasing the proportions of one or the other ingredient as need may arise.

The question now arises: Should the mixed developer be applied at once to the plate, or should the pyro, the alkali, or the bromide be first used?

If the time of exposure were always correct, there can be no doubt that the best method would be to apply the mixed developer. But the exposure is always more or less doubtful; it is nearly always necessary to modify the developer in one way or another, to meet special needs.

It would, then, seem more scientific to begin with a part of the developer, and to add the other ingredients in small quantities as required. Since the effect of a preliminary application of pyro is to slow the plate, the author's practice is to flood it first with a solution containing about half the quantity of pyro likely to be needed, and to add the alkali in small increments, as required to bring out detail, finishing up with the rest of the pyro, to give density, using the bromide only in cases of necessity. This is for time exposures.

For instantaneous exposures the method is reversed; the

plate is first flooded with a weak solution of the alkali, and the other ingredients added as required.

In this connection it may be stated that the author's preference is for slow development, as giving the operator time to see the needs of the plate and meet them before it is too late. Hasty development has ruined many a plate which might have been saved by a more judicious treatment.

The development should, as a rule, be continued until the image is fairly visible at the back of the plate.

Density.—Excess of pyro or prolonged development will increase density. The amount of density which it is desirable to give to the image, depends on the nature of the surfaces on which the positive is to be printed, since negatives adapted to one kind of surface are not always suitable for others. For instance, the negative which will give good results on albumenized paper, will not necessarily produce equally good prints on matt surfaces, as the platinotype, bromide, and plain papers.

For printing on albumenized paper, the negative should show all the detail in the shadows and be of moderate density, since albumenized paper renders the most delicate gradations. For matt prints, and photogravures or heliogravures, however, there should be as little deep shadow as possible in the negative, and a small amount of high light, not more than one-fourth. Most of the tones should be half-tones, subdued lights, and well-illuminated shadows, with great opacity in the high lights, for photo-engraving purposes, and not too intense for matt surface prints, which do not render well details in the deepest shadows.

The amount of density must then be determined by circumstances, and the operator will seek to give his negatives those special qualities which best fit them for the purposes to which they are to be put.

The Quantity of Pyro and Alkali to be Used.—Excess of pyro or alkali is equally disastrous, the first producing too great density, the latter giving foggy images. While it is impossible to give any exact proportions, the author, after comparing many formulæ, finds that two and a half grains of pyro and four grains of carbonate of potash, or ten grains of car-

bonate of soda, or two drops of ammonia, to each ounce of mixed developers, is a fair average. In special cases the pyro may be increased to five grains to the ounce, but the quantity of alkali should not greatly exceed the quantities given, or fog may result.

It is hoped that these remarks may make the intelligent use of the following developers more easy.

Pyrogallic Acid Developers.

No. 1.—Cooper's Formula.

a. Sulphite of soda.....6 ounces
Water.....1 quart

When dissolved add

Pyrogallic acid..... 1 ounce

b. Carbonate of soda, pure..... 4 ounces
Water..... 1 quart

Developer: *a* 1 ounce; *b* 1 ounce; water 1 ounce. Restrain with bromide of potassium.

No. 2.—Beach's Formula.

A.—*Pyro Solution.*

Warm distilled water..... 2 ounces
Sulphite of soda..... 2 ounces

When dissolved and cool add

Sulphurous acid..... 2 ounces
Pyrogallol..... ½ ounce

B.—*Potash Solution.*

1.—Water..... 4 ounces
Carbonate of potash, c. p..... 3 ounces

2.—Water..... 3 ounces
Sulphite of soda..... 2 ounces

Combine 1 and 2 into one solution.

For a shutter exposure take 3 ounces water, ½ ounce A, and 3 drams B, increasing the latter to 5 drams if the image hangs back.

For over-exposure 3 ounces water, 3 drams A, 1 dram B, adding more if necessary.

No. 3.—The Author's Formula.

a. Water.....10 ounces
Sulphite of soda..... 1 ounce

Dissolve and add

Pyrogallic acid..... 1 ounce
Sulphuric acid.....20 drops

b. Water.....10 ounces
Carbonate of pytash..... 1 ounce

c. Water.....10 ounces
Carbonate of soda..... 1 ounce

Normal Developer.

Water..... 4 ounces
Solution *a*..... 3 drams
Solution *b*..... 2 drams
Solution *c*..... 2 drams

These quantities may be increased if necessary. An excess of *b* over *c* gives soft harmonious negatives full of detail; when *c* is in excess more density and less detail is gained.

No. 4.—Carbutt's Formula.

a. Distilled water.....10 ounces
Sulphite of soda..... 4 ounces

Dissolve and add slowly

Sulphuric acid..... 1 dram
Pyrogallic acid..... 1 ounce

And water to make 16 fluid ounces.

b. Granulated carb. of potash..... 2 ounces
Granulated carb. of soda..... 2 ounces
Water.....10 ounces

Dissolve and add water to make 16 fluid ounces.

Normal Developer.

Water..... 4 ounces
Solution *a*..... 3 drams
Solution *b*..... 2 drams

No. 5.—Edwards' Formula.

a. Pyrogallic acid..... 1 ounce
Glycerine..... 1 ounce
Alcohol..... 6 ounces

b. Bromide of potassium.....60 grains
Ammonia..... 1 ounce
Glycerine ..... 6 ounces
Water..... 6 ounces

Normal Developer.

a. Solution *a*..... 1 part
Water.....15 parts

b. Solution *b*..... 1 part
Water.....15 parts

Mix equal parts of *a* and *b*. If the image flashes up quickly pour off the mixed developer, and flood the plate with solution *a*.

No. 6.—Henderson's Formula, with Ferro-Cyanide of Potassium.

Saturated solution of ferro-cyanide of potassium...10 ounces
Ammonia.....10 drops
Pyrogallic acid.....15 grains

This solution keeps well. If it refuses to develop add a few drops of ammonia.

No. 7.—E. Von Sothen's Hydrochinone Developer.

a. Carbonate of soda..... 60 grains
Water..... 1 ounce

b. Hydrochinone.....12 grains
Sulphite of soda.....60 grains
Water..... 1 ounce

Normal Developer.

Water..... 1 ounce
Solution *a*..... 1 ounce
Solution *b*..... 2 ounces

The mixed developer can be used many times.

No. 8.—Dr. Martell's Soda, Potash, and Ammonia Developer.

a. Pyrogallic acid ..... 1 dram
Citric acid..... 5 grains
Sulphite of soda..... 1 dram
Water.....10 ounces

b. Carbonate of potash..... 1 ounce
Water.....20 ounces

c. Bromide of ammonium.....15 grains
Ammonia..... 1 dram
Water.....20 ounces

Normal Developer.

a, *b*, and *c*..... equal parts

Notes on the General Composition of Developers.

The Oxalate of Iron Developer.—In this developer, commonly known as the ferrous-oxalate developer, the only function of the oxalate of potash is to produce, when combined with sulphate of iron, the powerful reducing agent, oxalate of iron, which is a compound insoluble in water, but soluble in an excess of oxalate of potash. If, on the addition of the iron solution to the oxalate of potash, the oxalate of iron is thrown down in the shape of a yellowish powder, it is a sure indication that there is a deficiency of the oxalate of potash. In this case the developer must be rejected and a fresh one mixed, containing less iron.

The oxalate of potash must be neutral or slightly acid. If the oxalate solution shows an alkaline reaction, turning red litmus paper blue, oxalic acid must be added to restore the red color to the paper.

The sulphate of iron solution does not keep well unless tartaric acid is added ; the solution must then be kept in the sun.

Old oxalate of iron developer may be kept in good condition by the occasional addition of a few grains of tartaric acid and keeping it in the sun. Old developer is useful to start development with.

Alkaline Developers.—In this form of developer the pyro is the reducing agent, the other ingredients are either accelerators, restrainers, or preservatives added to prevent the too rapid deoxidation of the pyro.

When using pyro the author prefers to begin with a developer weak in pyro and alkali, adding more of each as required. Plates known to have received a full exposure should

be soaked for two or three minutes in a plain pyro solution, adding the accelerator in small quantities.

Potash, soda, and ammonia are accelerators; sulphite of soda is a preservative, and bromide of potassium a restrainer.

Excess of pyro gives great density with little detail; excess of accelerator gives plenty of detail but little density. Bearing these principles in mind the intelligent operator is able to modify his developer to suit special cases.

The Hydrochinone Developer.—This form of developer is but little known, owing chiefly to its expensiveness, hydrochinone being manufactured only in small quantities.

Its many good qualities, however, should recommend it. It is a more powerful reducer than pyro, but slower and more uniform in its action; it does not oxidize as quickly as pyro; it gives a velvety black image with great cleanness in the shadows, and it does not stain. For transparencies and opals it is far superior to pyro or oxalate of iron.

The Alum Bath.—When the development is completed, the negative should be immersed for five minutes in a five per cent. solution of alum. This hardens the film, thus preventing frilling, and in the case of pyro-developed negatives, removes any coloration of the film caused by the oxidation of the pyro.

The alum bath may be used for many negatives, but the same bath must not be used both for iron and pyro-developed negatives.

Fixing.—The negative is washed slightly after leaving the alum bath, and fixed in a one to five hyposulphite of soda solution. It should remain in this bath for some time after the creamy appearance has left the plate.

Washing.—In order to eliminate thoroughly all traces of hypo, the plates must receive a thorough washing in many changes of water, or, better still, in running water.

The different methods of washing will be found described in Chapter II.

When the negatives are thought to be sufficiently washed, a small quantity of the drainings should be placed in a beaker

and tested for hypo, using for that purpose the following solution :

Permanganate of potash	2 grains
Carbonate of potash	20 grains
Water	40 ounces

The addition of a few drops of this rose-colored solution to a pint of water will produce a slightly pink tinge. If any hypo be present this color will give place to one of a slightly greenish hue.

If this test detects hypo the washing must be prolonged, or the plates may be immersed for a short time in the following hypo-eliminator :

BELLITZKI'S HYPOCHLORITE OF ZINC—HYPO-ELIMINATOR.

a.	Chloride of lime	304 grains
	Water	35 ounces
b.	Sulphate of zinc	610 grains
	Water	100 ounces

Add *b* to *a* and shake well.

Set aside for some hours and decant the clear liquid, which must be kept in well-stoppered bottles. It retains its good qualities as long as it smells of hypochlorous acid.

For use add one part of the solution to sixty parts of water.

After this treatment the plate is washed for ten minutes, all adhering spects removed with a soft sponge, and dried spontaneously.

Intensifying.—Many negatives are wanting in density owing to over-exposure or insufficient development. In such cases intensification must be resorted to in order to increase the density. The bichloride of mercury intensifier in its common form will be found in Chapter II. It is, perhaps, as good as any.

If preferred, one of the following formulæ may be substituted for it.

Dr. Eder's.—The negative is whitened in a saturated solution of bichloride of mercury, and after thorough rinsing immersed in

Potassium cyanide	10 parts
Potassium iodide	5 parts
Mercuric chloride	5 parts
Water	2000 parts

and well washed.

Thompson's Cyanide of Silver Method.—The negative is whitened in the following:

Bichloride of mercury	10 grains
Chloride of ammonium	10 grains
Water	1 ounce

It is then well washed and blackened in

a.	Cyanide of potassium	2 ounces
	Distilled water	48 ounces
b.	Nitrate of silver	1 ounce
	Distilled water	6 ounces

Mix *a* and *b* by pouring *b* gradually into *a* with constant stirring. Allow the mixture to stand a few days before using.

The Gallic Acid and Nitrate of Silver Intensifier.—Dr. Wallace and Mr. Bartlett have recently worked out a modification of an old wet plate intensifier which makes it applicable to gelatine emulsion plates.

The author has found it reliable and efficient.

The following solutions may be kept in stock:

1.	Perchloride of iron	4 grains
	Chrome alum	2 grains
	Citric acid	4 grains
	Water	1 ounce
2.	Gallic acid	80 grains
	Alcohol	1 ounce
3.	Nitrate of silver	40 grains
	Water	1 ounce

For use add one dram each of 2 and 3 to two or three ounces of water.

The negative is soaked for a few minutes in solution 1, in which it should not be allowed to bleach unless it is slightly fogged or over-developed.

The plate is then rinsed under the tap, and sufficient of solutions 2 and 3 diluted as directed, is flowed over it and allowed to act until the proper degree of density is reached. After which it is well washed.

This method is applicable either before or after fixing. In either case the negative must be well washed.

Uranium Intensifier.—The plate is flooded with a one per

cent. solution of nitrate of uranium. After remaining on the plate for a minute it is poured back into the graduate, in which a few drops of a two per cent. solution of ferricyanide of potassium have been placed. The mixture is then poured back on the plate. If this does not give sufficient density add more of the ferricyanide.

This is one of the most permanent of intensifiers.

Reduction.—It occasionally happens that negatives have too great density. In this case the density must be reduced. This may be done with either of the following solutions:

FARMER'S REDUCER.

Ferricyanide of potassium (saturated solution)..... 1 part
Hyposulphite of soda solution (one to five).....10 parts

BELLITZKI'S REDUCER.

Potassium ferric oxalate.....1 to 10 grains
Hyposulphite of soda solution (one to five)..... 1 ounce

Local reduction can be made by mixing the preparations with mucilage and applying with a brush. Wash well after treatment.

Varnishing.—All negatives worth preserving should be varnished. The method of applying the varnish will be found on page 30. A few additional formulæ are given here:

1. Sandarac..... 4 ounces
   Alcohol.....28 ounces
   Oil of lavender..... 3 ounces
   Chloroform..... 5 drams
2. White hard varnish..... 15 ounces
   Methylated alcohol.....25 ounces

This will be found a good and cheap varnish if durability is not required, as it is easily rubbed up for retouching upon and easily cleaned aff. Very suitable for enlarged negatives that are not to be retained.

TOUGH, HARD, AND DURABLE.

3. Shellac..... 1¼ ounces
   Mastic..... ¼ ounce
   Oil of turpentine..... ¼ ounce
   Sandarac..... 1¼ ounces
   Venice turpentine..... ¼ ounce
   Camphor.....10 grains
   Alcohol.....20 fluid ounces

4. Sandarac ..... 90 ounces
   Turpentine ..... 36 ounces
   Oil of lavender ..... 10 ounces
   Alcohol ..... 500 ounces

This one may be rubbed down with powdered resin to give a good retouching surface:

5. Sandarac ..... 4 ounces
   Seed lac ..... 1 ounce
   Castor oil ..... 3 drams
   Oil of lavender ..... 1½ drams
   Alcohol ..... 18 ounces

COLLODION VARNISH.

6. Tough pyroxyline ..... 12 grains
   Alcohol ..... 1 ounce
   Ether ..... 1 ounce

Flow over the plate as in collodionizing, drain well, and dry.

CHAPTER XII.

PAPER NEGATIVES. STRIPPING FILMS ON PAPER, CARDBOARD, AND COLLODION.

The latest development in photographic negatives is a return to first principles, the use of paper as a permanent or temporary support for the sensitive film.

It is not the writer's intention to enter into a discussion of the advantages or disadvantages of the new method. The writer's own opinions on the subject are decided and based on practical experience in the field and in the dark-room, but he is content to keep those opinions to himself, simply giving detailed descriptions of the manipulations peculiar to the use of paper or other similar support as a substitute for glass.

For various reasons collodion does not seem to take kindly to paper; therefore it is to be assumed, of all the methods here given, that the sensitive film is formed by coating the paper with one of the emulsions given in chapter VIII.

The use of paper as the support does not necessitate any change in the nature of the emulsion, except, perhaps, that a slight increase in the quantity of gelatine may be advisable, or a decrease in the amount of water.

Any changes which are recommended are necessitated by the flexible nature of the support, and the somewhat different conditions under which the emulsion must be flowed over it.

Radical differences exist between the preliminary manipulations of paper intended as a permanent support, and those to be employed when the film is to be finally removed from the paper.

Each of these will be treated in turn, beginning with those to be used when the paper is to form the permanent support.

The Paper.—When the paper is to form the final support of the negative, great care must be taken to select a variety

presenting the greatest uniformity of surface, and freedom from grain. The kind known as plain Saxe negative paper is well adapted to this process. Parchment paper, if it could be had free from marks and lines, would be the best, since its use would render the after operation of oiling unnecessary.

Whatever brand of paper be selected, its right side is the one to be coated. Neglect of this precaution will result in grainy and spotted negatives, due to the unevenness of the unpolished side of the sheets.

Sizing the Paper.—If the paper selected be strongly sized, it may be coated without further preparation. Better results, however, will be obtained on paper which has received a coating of coagulated albumen or insoluble gelatine. Both of these may be obtained of any dealer in materials for the carbon process, or, if preferred, the experimenter may prepare his own paper, by floating it for a minute on the following bath :

Hard gelatine	4 ounces
Sulphate of baryta (powdered)	2 ounces
Water	20 ounces

Dissolve and mix thoroughly ; then stir in a hot solution of six grains of chrome alum in one ounce of water.

The paper is coated by rolling it up tightly, face outwards ; the roll is laid upon the surface of the liquid, the loose end is seized and the paper unrolled ; it is then hung up to dry.

Paper possessing a high degree of transparency may be prepared by soaking the sheets for some days in copal varnish, and then drying. When dry the surfaces are polished with pumice stone, after which a layer of soluble glass is applied and well rubbed in with a piece of cloth. Some small experiments of the author in this direction have resulted favorably, the emulsion readily flowing over the prepared surface.

Coating the Paper.—The prepared sheets may be coated with the emulsion by the method just described, having been first slightly dampened. The tray containing the emulsion is placed in a larger tray containing water, the temperature of which is kept at about 70 deg. The paper is rolled up as before and floated on the emulsion, avoiding air bells. It is then seized by one end and drawn over the edge of a glass plate,

previously levelled over the tray. As soon as the film is set the paper may be stripped from the glass and hung up to dry.

Another very good method is that sometimes used in the preparation of carbon tissue, and shown in Fig. 28. The description of the apparatus is from "Abney's Treatise on Pho-

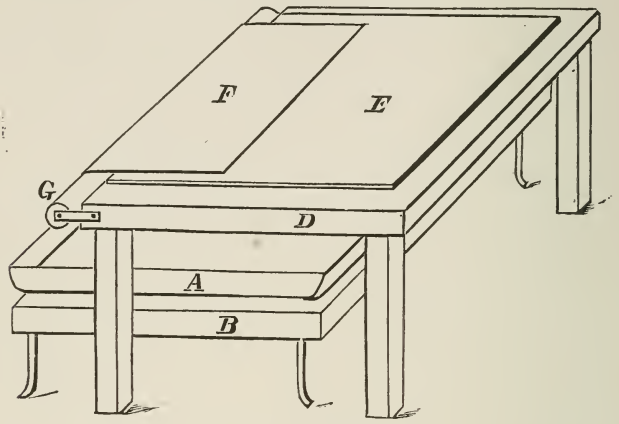

Fig. 28.

tography." A porcelain or other dish, A, is placed on a hot water tin, B, the water being kept at the boiling point by a lamp or Bunsen burner. Over the dish is placed a level table, D, at one end of which is a roller, G, that is on a level with the top surface of a glass, E, placed on the table, D. The paper, F, is floated on the warm gelatine solution contained in the dish, drawn through it, seized by the hands, drawn over the roller on to the plate, E, where it is allowed to remain till the gelatine is well set; after which it is hung up by clips to dry. The dish has to be removed each time that paper is floated; if B be widened, the dish can be run backwards and forwards in a very simple manner.

Another simple method is to soak the paper in warm water until limp, then to place it on a glass plate, and with blotting-paper and a squeegee, to remove all excess of moisture. The paper may then be coated as if it were a glass plate. After being coated it is placed on the levelling slab until the film is well set, after which it may be hung up to dry, or allowed to dry on the glass.

This is the simplest method, and for most purposes it will be found as good as any.

Another method, which is preferred by some operators, is to coat a glass plate, previously polished with French chalk, with the emulsion, and when the film has thoroughly set, gently to squeegee the moistened sheet of paper in perfect contact with the film. When dry, the paper bearing the film may be pulled from the glass.

A glass roller may be used to equalize the film. This roller is made by inserting corks in the ends of a piece of glass tubing, one-half inch in diameter, and a trifle longer than the width of the paper to be coated. About one-eighth of an inch from each end rubber bands surround the rod. These serve to keep the rod slightly above the surface of the paper, and their thickness determines that of the film. Short pieces of wire are inserted in the corks, the ends of a bent wire are bent around these wires, to form a handle by which the rod is manipulated.

The emulsion is poured on the paper in parallel lines between the rod and the handle; the rod is then drawn backwards and forwards over the paper to equalize the film.

The glasses on which the sheets of paper are squeegeed must be a trifle wider than the paper, in order that the rubber bands may rest on the glass. The distance between the bands should just equal the width of the paper.

The emulsion may also be spread over the paper with a stiff brush.

Balagny's Method.—M. Balagny prefers to paste the paper to the glasses, over which has been flowed a thin film of the following solution:

Benzine	3¼ ounces
Gum dammar	15 grains
White wax	30 grains
Resin	15 grains

This solution is flowed over the glass like collodion and the glass is racked away to dry.

The paper, cut to size, is first soaked in water till limp, and then given an even coating of thin starch paste, free from lumps, and laid down on the glass, the starched side of the

paper in contact with the waxed surface of the glass. The face of the paper is then covered with a sheet of blotting-paper, and all excess of paste, as well as all air-bells, removed with the squeegee. When dry, the paper is coated and the film allowed to dry on the glass; the paper is then stripped from the glass by raising one corner first.

The advantage of this method is that the paper is kept in perfect contact with the glass, on which it is tightly stretched, and that there is no possibility of its cockling or rolling up as it dries.

Stripping Films. Paper Support.

Chennevière's Method.—The glasses are waxed as in Balagny's method given above. The paper is cut somewhat smaller than the plates, softened in water, and laid down on the plate, leaving a narrow margin of glass on all sides. Excess of moisture and air-bells are removed by means of blotting-paper and the squeegee. Narrow strips of albumen paper are then pasted around the paper and glass, and when dry the paper is given a thin coating of French chalk, all excess being removed with a camel's-hair brush, and then collodionized with the following plain collodion:

Ether	1⅝ ounces
Gun-cotton	15 grains
Alcohol	1⅝ ounces
Castor oil	10 drops

As soon as the collodion is dry the paper is coated and allowed to dry on the glass. It can then be stripped from the glass by cutting along the edges of the albumen paper.

The only disadvantage of the above method is the liability of the films to leave the paper when cut down to smaller sizes. To obviate this difficulty, M. Chennevière has introduced the following improvement: The paper is given a coating of a waxing solution made as follows:

White wax	61 grains
Benzine	3¼ ounces

This is applied with a piece of linen dipped in the solution. The paper when dry is dampened and fastened to the glass as

before. It is then collodionized, and when again dry coated with the emulsion.

Balagny's Method.—The paper is pasted on the glass as described on page 133, and, when dry, is polished with French chalk, a moderately thick coating being given in order to fill the pores and leave a smooth surface. It is then collodionized with the following plain collodion:

Pyroxyline	23	grains
Alcohol	3	ounces
Ether	4¾	ounces

When dry, the paper is coated as usual and allowed to dry on the glass.

Fabre's Method.—Plain paper of good body is given a coating of Para gum dissolved in benzine (gum 30 grains, benzine 3 ounces), and hung up to dry in a place free from dust.

When dry it is moistened and squeegeed into perfect contact with a glass plate previously waxed as in M. Chennevière's method, coated as usual, and stripped from the glass as soon as the film has set, and then hung up to dry.

The rubber solution must be well filtered through several thicknesses of muslin, and it is conveniently applied to the paper with a brush, placing the paper on a glass plate and giving it a thin coating.

Milsom's Method with Waxed Paper.—The paper is cut one-half an inch longer and wider than the glass supports. It is then soaked for five minutes in water, and then pasted by its edges on its glass support. For this purpose the paper is laid down on moist blotting-paper, with the side to be coated in contact with the paper. The glass plate is then placed over the paper, the edges of the latter are then turned over and glued or pasted to a sheet of common paper of the proper size. Dry between blotters under moderate pressure.

When dry place the glass on a metal plate warmed to above the melting point of wax. With a piece of white wax go carefully over the entire surface of the paper until it is evenly waxed and no air-bells remain between the paper and the glass. Then remove the glass from the metal plate and remove all

excess of wax by gently rubbing with a piece of clean flannel. The glasses are then dried under pressure, the waxed surfaces being placed in contact. When dry, coat as usual.

Eastman's Method.—The paper is first coated with a plain gelatine solution containing 15 to 20 grains of soft gelatine to the ounce of water. When dry, the paper is again coated with any good emulsion which has been made insoluble by the addition of chrome alum.

To every 500 parts of emulsion 15 to 20 parts of the following alum solution is added :

Chrome alum	4 parts
Water	90 parts
Glycerine	40 parts

An emulsion containing chrome alum should all be used at once.

Stripping Films on Cardboard Supports.—Any of the methods described above, for preparing paper to serve as a temporary support, may be employed when cardboard is used.

The simplest method is to polish the cardboards with French chalk, and after dusting off all excess of chalk to collodionize them with any good, plain collodion, the formula given on page 50 will answer. The prepared cards are thoroughly soaked in water, and then squeegeed, collodion side uppermost, on glass plates somewhat larger than the cards. The edges are secured to the glass with gummed paper, and when dry the cards are coated as usual.

If preferred, the cards may be waxed with the solution given on page 51, before collodionizing, or they may be given two coats of shellac.

Balagny's Method with Methyl Alcohol.—To obviate the difficulty of determining the proper point at which to cease the development of films on paper or cardboard, owing to the impossibility of judging of their density by transmitted light, M. Balagny has worked out a method which gives films which leave their support when placed in the developer.

Glass plates are polished with French chalk, dusted off, and coated with any good emulsion.

When dry the films are collodionized with the following collodion:

Ether	3½ ounces
Methyl alcohol	3½ ounces
Pyroxyline	30 grains
Castor oil	1 dram

The paper or card supports are moistened in water, placed upon a clean glass, and all excess of moisture removed with blotting-paper and the squeegee, both sides being thus treated. A ten per cent. solution of pure gum is then laid on with a brush, after which the paper or card is carefully laid down on the prepared plate and squeegeed into contact.

As soon as the support is dry it is stripped from the glass by cutting around the edges with a sharp knife, and pulling the paper or card from the glass.

After exposure these films are soaked for three or four minutes in a one per cent chrome alum solution, then in pure water until the film begins to wrinkle. It is then carefully removed from its support and placed in the developer.

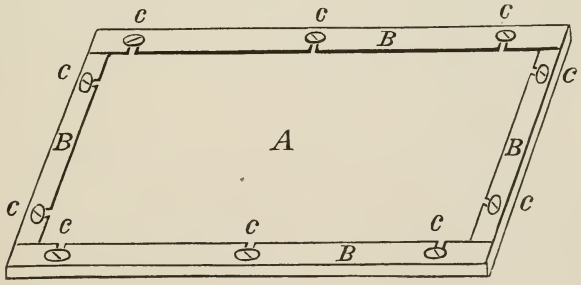

FIG. 29.

Figure 29 shows a coating-board, devised by the author, for coating cards. It has been found useful for holding the cards while being waxed or polished and collodionized, as well as while being coated. It will also answer for holding paper.

A is a half-inch slab of hard-wood, battened at the ends to prevent warping, planed and sand-papered perfectly smooth. Its length and breadth are a trifle in excess of the size of the cards or paper to be coated.

B, B, B, B, are movable half-inch strips of thin metal well shellacked or japanned, and having slots cut in them, as shown. C, C, C, are ordinary flat-headed screws, which serve to clamp the metal strips. The slab is levelled with levelling screws or wedges.

The paper or cards to be coated are first cut somewhat larger than the size desired, moistened in water and laid smoothly on the slab from which the metal strips have been removed. All excess of moisture is removed, and perfect contact secured with blotting paper and the squeegee. The strips are then placed in position and tightly screwed down, in which condition they act as clamps to hold the paper tightly stretched. If the paper is to serve as a permanent support, the emulsion is poured on immediately, and evenly distributed with a glass rod, the ends of which rest on the side strips, which determine the thickness of the film.

If stripping films are desired, the paper, or cards, when dry, is polished and collodionized as described above, and then coated.

When the films are set the paper may be removed from the slab and hung up to dry. The author, however, prefers to allow the film to dry on the slab.

Pellicular Films without Support.

Balagny's Method.—Clean glass plates are polished with French chalk, dusted, and collodionized with the plain collodion given on page 135, and, when dry, coated with an emulsion containing 35 ounces of water and 1080 grains of gelatine for every 770 grains of nitrate of silver.

When the films are dry they may be detached from the glass by cutting around the edges, first detaching one corner from the plates.

These films will be strong enough to undergo all the necessary manipulations.

Another method of preparing films without support, is to polish and collodionize the plates, then to paste narrow strips

of pasteboard around their edges, and to coat them with the following gelatine solution:

Water	14 ounces
Hard gelatine	1,080 grains

Soak the gelatine in cold water, dissolve, and add

Water	3½ ounces
Chrome alum	7 grains
Glycerine	1 dram
Ferric acid	40 drops

This is to be added in a fine stream, with constant stirring. The mixture is then well filtered, and the plates coated. When dry they are coated with the emulsion, and the dried films are stripped from the glass, as in the preceding method.

The author sees no great advantage in these two methods over the usual stripping processes. They are given to demonstrate the possibility of preparing a sensitive film, having all the transparency of glass, without its bulk or weight.

Methods of Exposing Films on Paper Supports.—Many methods of exposing films on flexible supports have been devised. Most of those recently put forth for gelatine films are as old as the calotype process, and possess few or no claims to novelty.

For the exposure of emulsion paper, in long rolls, the roll-holder, in some one of its modern forms, is certainly the best method for the tourist who does not care to develop his exposures until he returns home.

The stay-at-home photographer, however, who only exposes a plate now and then, and develops it at once, will use simpler and less expensive methods, better suited to his needs.

Many forms of film-carriers are now in the market, of which the best known, perhaps, is the Eastman, which consists of a thin tablet of wood surrounded by a light detachable metal frame, in which the sensitive tissue, cut to size, is laid face down, and the back-board placed in position, when the whole is introduced into the plate-holder, exactly as if it were the usual plate.

Another effective method is to coat thin pieces of shellacked wood with the following mixture:

Water	4	ounces
Sulphate of baryta	2½	ounces
Sugar	1	ounce
Gelatine	1	ounce
Glycerine	6	ounces

The wooden tablets are levelled and given a thin coating of the mixture, which may be applied with a brush. The sensitive film is laid down on one of the prepared tablets, and gently smoothed into contact. It is easily removed for development, and the prepared tablets will answer for several exposures.

Still another method is to gum the tissues by the edges to a glass plate, a thin wooden tablet, or a piece of stiff cardboard.

A fourth method, applicable to single holders, is to place the tissue between a clean glass plate and a sheet of cardboard. If this method be employed, care must be taken to allow for the thickness of the glass in focusing. The best method seems to be that adopted in the Vergara double holder, in which the sensitive tissue, cut to twice the length of a single sheet, is folded across the middle, and the end of the septum placed in the fold, and the whole slid into grooves cut in the holder.

Films on cardboard are placed in the holders exactly as glass plates. Pellicular films on collodion or gelatine are best exposed behind a glass plate.

Development.—The development of films on paper or cardboard supports is carried out precisely as in the case of glass plates, using any of the developers given in the previous chapter, preferably the oxalate of iron developer, or those modifications of the alkaline developer which contain sulphite of soda.

Good, full exposures give the best results with stripping films. Long development with pyro is very apt to tan or harden the soft gelatine substratum, owing to the penetration of the developer through the pores of the paper, and so make stripping difficult or impossible.

For this reason most of those who make use of stripping films, adopt the oxalate of iron (ferrous oxalate) developer.

The following formulæ and directions are those recom-

mended by the Eastman Co., for their films, but they will be found equally applicable to others:

No. 1.

Sulphite sodium, pure, crystals..... 6 ounces
Distilled or boiled water, cold.....1 qt. (32 ounces)
Pyrogallic acid..... 1 ounce

Dissolve the sulphite first and then add the pyro.

No. 2.

Carbonate soda, pure..... ¼ pound
Water.....1 quart

To develop, pour into a clean tray the following:

No. 1.....1 ounce
No. 2.....1 ounce
Water.....1 ounce

Immerse the exposed film in a tray of clean, cold water, and, with a soft camel's hair brush, gently remove the air bells that cling to the surface of the film. As soon as limp, remove the film to the tray containing the developer, and proceed with the development the same as with a dry plate. The image should commence to appear in ten or fifteen seconds. If the lights come slowly and with no detail in the shadows, add not to exceed one ounce of No. 2. If the image appears too quickly, add ten to twenty drops of the

Restrainer.—

Bromide potassium.....1 ounce
Water.....6 ounces

Keep this in a dropping bottle, consisting of an ordinary bottle having two notches cut lengthwise in the cork, on opposite sides.

Oxalate Developer.—The oxalate developer works well with Eastman's American films, and it has no tendency to attack the soluble substratum and render it insoluble.

Formula.—No. 1.

Oxalate of potash..... 1 pound
Hot water..... ....48 ounces

Acidify with Oxalic acid.

No. 2.

Proto-sulphate of iron	1 pound
Hot water	32 ounces
Tartaric acid	60 grains

No. 3.

Bromide potassium	1 ounce
Water	1 quart

These solutions keep separately, but must be mixed only for immediate use.

To Develop.—Take No. 1, six ounces; No. 2, one ounce; No. 3, ten drops. Mix in the order given; use cold.

After exposure, soak the paper in water until limp, then immerse in the developer.

The image should appear slowly and should develop up strong, clear, and brilliant. When the lights are sufficiently developed, wash well and fix.

After fixing, wash in three or four changes of cold water for five or ten minutes, and the film is then ready for transferring.

When the oxalate developer is used, it is sometimes advisable to use alum in the fixing-bath, to prevent frilling, but after using it the paper must be stripped as quickly as possible after squeegeeing on to the glass; that is to say, after standing thirty minutes under pressure and before it becomes entirely dry, otherwise the substratum will become insoluble.

The film may be examined from time to time by transmitted light, by holding it up by the corners. When sufficient density is obtained, wash the film in two changes of cold water, and then immerse in the

Fixing-Bath.—

Hyposulphite sodium	4 ounces
Water	1 pint

Mix fresh fixing-bath for each batch of negatives. Use no alum in the fixing-bath.

Films fix quicker than glass dry plates, and the completion of the operation can be ascertained by the even, translucent appearance as seen from the back while lying in the bath, or by examination by transmitted light.

Drying.—Paper negatives, if not to be stripped, are best

dried on a piece of glass, well polished with French chalk, or on a sheet of ebonite. The negative is squeegeed into contact with the glass or ebonite, and allowed to dry spontaneously. When dry it will peel off with a brilliant gloss.

Oiling.—Paper negatives, when dry, may be printed from without further treatment. It is better, however, to render them more translucent by oiling or waxing. Many methods have been advocated for increasing translucency.

The author usually adopts the following method: The negative is secured, face down, to a clean flat board, by thumb tacks at the corners. The oiling medium, castor oil, vaseline, or translucine, is then applied to the back; the negative is then held over a stove and kept in constant motion until it assumes a uniform dark color. It is then allowed to cool, and a second coat of oil is applied and heated as before. All excess of oil is then removed with a piece of sponge or clean rag.

Retouching.—Paper negatives are best retouched from the back after oiling. The oiled surface takes the pencil readily, and any amount of working up may be given to the negative.

Printing.—Lay the negative, film side up, on a clean glass plate, secure the corners with gummed paper, and place in the printing frame.

Preserving Paper Negatives.—Place a sheet of oiled paper between the backs of the negatives and keep under pressure; a deep printing frame makes a convenient press.

Intensification, if necessary, should be done before the negatives are oiled.

Stripping Films.—The development of films which are to be stripped from their temporary supports is the same as that given above for paper negatives.

After development, fixing, and washing, they are prepared for stripping in some one of the following methods:

Eastman's Method for "American Films."—Coat a clean glass plate, one size larger than the film, with the following rubber solution:

Rubber cement	1 ounce
Benzine	9 ounces

The above rubber cement is such as sold at the rubber stores

in half-pound cans for 25 cents, and is a mixture of pure rubber and benzine. This article should not be mistaken for the bi-sulphide of carbon and rubber cement used by shoemakers.

Allow the rubber to dry until "dead," say five or ten minutes, then flow with plain collodion made as follows:

Ether	1 ounce
Alcohol	1 ounce
Gun-cotton	12 grains

As soon as set, wash under tap until greasy lines disappear, then slide the prepared glass into a tray of water, face up, slide the fixed and washed American film negative into the water over the plate, face down, grasp together by the edges and draw plate and negative out of the water, allowing to drain from one end. Carefully squeegee into contact, examining from front for air-bells, place under blotter and weight to dry for thirty minutes only, then slide plate supporting the negative into a pan of water about 120 deg. to 140 deg. Fahr., raise corner of paper with a pin and pull it off, or slide the paper off from the glass sidewise, using gentle pressure, leaving the negative film on the glass. Brush gently with camel's-hair brush dipped in warm water, transfer plate to tray of cold water, negative side up, slide a gelatine skin of the proper size into water over negative, rough side up, allow skin to soak one minute, then grasp together with plate, and lift out of the water. Squeegee into contact, and stand to dry. When thoroughly dry, flow with plain collodion. When dry, cut around the edges and peel off the glass; remove adhering rubber from the face of the negative by gently rubbing with the palm of the hand, or with a tuft of cotton moistened with benzine.

The sheets of gelatine are soaked for five minutes in the following bath:

Water	35 ounces
Alcohol	2½ ounces
Glycerine	2½ ounces

After soaking, a gelatine sheet is carefully placed on the film and lightly squeegeed into contact. When dry, the nega-

tive is stripped off as before. It is advisable, however, to collodionize the gelatine backing with plain collodion before stripping.

Chennevière's Method.—Stripping-films prepared according to M. Chenneviere's method are developed, fixed and washed as usual. They are then squeegeed into contact with glass plates previously polished with French chalk and collodionized with plain collodion. When dry, the negatives are cut through to the glass near the edges and pulled from the plates. The film is separated from the paper by inserting a knife-blade between the two at one corner and pulling them apart.

Fabre's Method for Films on Paper Coated with Rubber.—The washed negatives are squeegeed into contact with polished and collodionized glass plates. When dry, the back of the paper is covered with benzine and rubbed with a cloth dipped in benzine, to dissolve the rubber. The paper is then removed, the back of the film gently rubbed with a soft cloth dipped in benzine, to remove all traces of rubber. After drying, the films are coated with a plain collodion, and, when again dry, they are stripped from the glass as usual, first cutting around the edges.

This method is applicable to all films united to paper supports with wax or collodion, as in the methods of MM. Balagny and Milsom, given above.

Films on Cardboard Supports are developed, fixed, washed and dried like glass plates. When dry, they are collodionized with plain collodion, and, when again dry, stripped from the cardboard support by inserting the point of a knife-blade between the film and card at one corner and pulling them apart.

The films are then placed in water in which a polished glass plate has been laid. After a moment's soaking, the collodion side of the film is brought in contact with the polished side of the glass, and the two removed from the tray. Perfect contact is secured with the squeegee, and the film allowed to dry. When dry, it is coated with plain collodion, and, when again dry, stripped from the glass as usual.

Films on Gelatine or Collodion Supports.—After the usual operations of development, fixing, and washing, M. Balagny

recommends that these films be quickly blotted off between clean blotters. They are then immersed for five minutes in the following bath:

Alcohol	16 ounces
Glycerine	1 ounce

They are then removed from the dish, drained for half a minute, placed between clean blotters and laid down on a glass plate. A piece of rubber cloth is next laid over the blotters and gently pressed with a roller, to remove all excess of moisture. This process is repeated three or four times, changing the blotters each time. The films are then dried thoroughly between fresh sheets of blotting-paper.

These flexible plates, as the inventor calls them, are superior to films on paper or cardboard, in that they allow the progress of development to be watched by transmitted light.

The author, however, has found no insuperable difficulty in judging of the density of films on paper or cards by reflected light. His practice is to develop until the shadows begin to gray over, and then to wash and fix as usual.

CHAPTER XIII.

FAILURES IN THE GELATINO-BROMIDE PROCESS.

Most of the possible causes of failure with this process with the proper remedies, will be found enumerated in this chapter.

Fluidity of the emulsion in the flask.—This is usually due to failure to add an antiseptic to the emulsion. Such an emulsion will not set, and is not safe to use.

Irregular flowing of the emulsion is most commonly due to the want of a substratum, and may be corrected by applying any of the substrata given in Chapter IV.

Wavy and irregular lines during coating are caused by the plates being too cold, or the emulsion not being sufficiently fluid. The plates should be warmed slightly, and the emulsion kept at a temperature of about 95 deg.

Refusal of the emulsion to set may be due to high temperature of the coating-room, or to a deficiency of gelatine in the emulsion, or to a decomposition of the gelatine, caused by long boiling, excessive use of ammonia, or frequent re-meltings. If the defect is due to the first cause, lower the temperature of the coating-room, which should always be at about 70 deg.

If the gelatine be deficient, add 25 or 30 grains of gelatine to every 2 drams of emulsion, and, after standing for a few hours, dissolve in the water-bath.

In the third case it is best to reject the emulsion.

Spots and small rings are due to the irregular drying of the plates. The door of the box or room in which the plates are dried should be opened as little as possible during the drying.

Fog is due to several causes, as over-exposure, forced development, admission of white light, or too long an exposure to the light of the dark-room.

If the edges of the plate, which were protected by the re-

bate of the frame, are free from fog, the plate was over exposed.

If the whole plate fogs over during development, it is either light-struck, or the emulsion was fogged.

This point may be determined by developing and fixing an unexposed plate. If this shows no signs of fog, the camera or the slide is at fault, and must be examined.

Fog on unexposed plates may be due to some fault in the making of the emulsion, or to the slow drying of the plates.

Fogged emulsion may occasionally be made fit for use by the addition of a few drops of tincture of iodine.

Plates which have been coated and show signs of chemical fog should be soaked in the following bath:

Bichromate of potassium	1 part
Hydrochloric acid	3 parts
Water	100 parts

After this treatment the plates are well washed and then dried.

Yellow fog occurs only with the alkaline developer; it is due to the staining action of pyro on the film, and may be removed by soaking the plates, after fixing, in a saturated solution of alum, to which one per cent. of hydrochloric acid has been added.

Red fog is caused by an excess of nitrate of silver used in the emulsion. It also sometimes occurs when the plate has been long subjected to the action of a concentrated oxalate of iron developer.

Green fog is most commonly caused by an excessive amount of ammonia in the developer. It may sometimes be removed by soaking the plate in a solution of peroxide of hydrogen.

A slight green fog does not injure the printing qualities of the negative. If, however, the fog is very dense, it may be cleared away by converting the deposit into chloride of silver, by means of perchloride of iron solution, to which a trifle of bromide of potassium has been added, and an after re-development with ferrous oxalate. If the original deposit chances to be too feeble for printing, expose the chloride of silver de-

posit to day-light before re-developing, which will increase the density very much.

A white opalescent veil, covering the film, is sometimes met with in plates developed with oxalate of iron, when lime is present in the water. It has no injurious effect, but may be removed by soaking the plate in dilute hydrochloric acid.

A yellow deposit forms on the film when using the oxalate of iron developer, owing to an excess of sulphate of iron having been added to the oxalate of potassium.

Undefined marks and spots on the film after development are due to grease in the gelatine. Emulsion prepared with ammonia is free from this defect.

Pinholes are caused by dust on the plate.

White marks or round spots are caused by air bubbles forming on the film during development. This may be prevented by soaking the plate in water before developing, or by keeping the developer in motion.

Lack of detail is caused by insufficient exposure, by want of sufficient alkali in the developer, or by the excessive use of the restrainer.

Want of density is due to over-exposure or to the use of a weak developer.

Excessive density is caused by over-development.

Halo around the high lights, is generally due to the reflection of light from the back of the plate. It may be, in part prevented by backing the plate with some non-reflecting color, mixed with gum water.

Matt surface plates, and those containing iodide of silver, are usually free from this defect.

Frilling of the film during development is most commonly caused by the use of soft gelatine in the preparation of the emulsion. The formation of frills and blisters is promoted by the addition of too much alkali to the developer, by the use of warm developers and wash-waters, by treating the plates with dilute acid solutions to remove fog or stains, and by the use of a concentrated fixing-bath.

Films which show a tendency to frill should be treated before or after development with 10 per cent. chrome alum solution.

Frills showing during development may be arrested by adding a teaspoonful of saturated solution of Epsom salts (sulphate of magnesia) to the developer. Plates with a tendency to frill should be placed in the alum-bath.

The best remedy for frilling is to work in a low temperature. Let the amateur defer developing, during hot summer, to the early morning hours, if he has no means of lowering the temperature of his work-room or water by artificial means.

Soaking in alcohol will usually remove films by the absorption of the water under them.

Slow fixing is due to the use of a too dilute, or too concentrated, hypo-solution for fixing. The proper strength is 1 to 5. Plates containing iodide are always slow to fix.

Spots and Stains appear on the films when intensified with mercury, owing to insufficient washing after fixing, or after the treatment with mercury.

Red stains, which appear on the films after having been printed from, are caused by the silver in the paper combining with the gelatine. They can sometimes be removed by soaking the films in dilute cyanide of potassium, accompanied by gentle rubbing, but this method is very dangerous. Dr. Ehrmann recommends that a line be drawn around the stains with a piece of wax sharply pointed; the film is then softened in water, and the spots are treated with cyanide of potassium solution applied with a fine brush.

Farmer's or Belitzki's reducing solutions, given on page 128, may also be applied in the same way.

The wax is removed with a tuft of cotton, moistened with ether.

CHAPTER XIV.

METHODS OF STRIPPING FILMS FROM GLASS PLATES.

Most of the mechanical printing processes require reversed negatives or positives for the production of the printing plate.

In such cases, unless a reversed negative was obtained in the camera, by the use of a reversing prism, or by exposing through the glass support, it is necessary to strip the film from the plate, in order to turn it and print from the reversed side.

The use of stripping films, prepared according to the instructions given in the previous chapter, gives negatives which can be printed from either side.

A few of the best methods for stripping are given below.

Collodion Films.—The plates are collodionized without being given a substratum. If the negatives have been varnished, the varnish is removed by pouring over them sufficient of the following solution to cover them well:

Distilled water	5 ounces
Caustic potash	120 grains
Alcohol	17½ ounces

The alcohol is used to neutralize the destructive effect of the alkali on the film.

As soon as the varnish is dissolved the negative is well washed in pure water, levelled, and coated with a solution of six parts of gelatine in forty parts of water, to which from four to five parts of alcohol, and from one-half to one part of glycerine have been added. When the gelatine has thoroughly dried, the film is cut around the edges and stripped from the glass.

For "process work" the film is turned by coating the negative, when dry, with a solution of Para gum in benzine, and

afterwards with a tough collodion. When this is dry the film is cut as before, and is immersed in a 1 to 10 acetic acid solution. As soon as the film floats off it is turned upon another glass plate placed in the solution, or glycerine. When again dry, the film may be pulled from the glass after cutting around its edges.

Gelatine Films.—Unless specially prepared for stripping, gelatine films must be treated with a 20 per cent. chrome alum solution, for at least one hour, and then immersed in a 20 per cent. hydrofluoric acid solution until the film leaves the glass. A polished and collodionized plate is placed in the tray, underneath the film, and both removed from the water, and laid down on a plain surface. A piece of sheet gelatine, previously soaked in water, containing 2 per cent. of glycerine is then brought in contact with the film, and, when dry, the film is easily detached from the glass.

A better method is to prepare the plates for stripping before they are coated. This is easily done by polishing them with French chalk, and collodionizing them with a plain collodion containing 1 per cent. of pyroxyline, first taking the precaution to remove the chalk from the edges of the plate, for about an eighth of an inch, with a wad of cotton wool, dipped in albumen. The plates are then coated with the emulsion.

To effect the transfer it is only necessary to cover the film after fixing, and washing with water containing 2 per cent. of glycerine, and then to lay over it a piece of sheet gelatine, previously soaked in the same glycerine solution. The whole is then covered with a piece of rubber cloth, and gently squeegeed.

When the gelatine sheet is dry it is collodionized, dried, and stripped, as described on page 144.

CHAPTER XV.

COLOR-SENSITIVE PLATES.

Isochromatic or Orthochromatic Methods.—The ordinary photographic plate, whether prepared by any of the well-known albumen, collodion, or gelatine methods, is deficient in its power of giving proper tone-value to the different colors. It does not render them with the same relative force with which they impress themselves upon the retina. Some colors appear too dark; others too light in the finished print.

Prof. Draper was the first to discover the fact that only the absorbed rays produce chemical changes in a sensitive surface.

The knowledge of this fact was the starting point in the search for substances which should make sensitive plates properly color-sensitive, by conferring upon them the property of translating the different colors of the spectrum into their true values in light and shade.

In this connection special mention is made of Angerer, Eder, Obernetter, Scolik, Mallmann, Ducos du Hauron, Cros, Tailfer, Josef Albert, Schumann, Vogel, Ives, Ehrmann, Abney, and Bierstadt, as investigators of this somewhat obscure branch of photography.

As the result of these investigations, it is now possible to prepare sensitive plates which will render, with great fidelity, the varying intensities of different colors.

The method is of great value in the reproduction of oil paintings, water-colors, colored fabrics, and, in general, of all objects in which there is a large proportion of red and yellow rays.

The problem to be solved was a method of treating emulsions or prepared plates, which should increase their absorption for rays which are but feebly absorbed by ordinary plates.

Two methods were found available to effect this result, one being to color the emulsion with certain dyes, the other, and more practical, being to bathe plates, prepared as usual, with a dilute solution of the same dyes.

It was also found necessary to interpose between the sensitive surface and the lens, or to place in front of the lens, colored screens in order to modify the action of the light to adapt it to the work it was called upon to perform.

Of the dyes most commonly used in the preparation of color-sensitive plates, those belonging to the eosine group have given the best results. Chinoline, and many others too numerous to mention, have also been successfully employed by different experimenters.

Without attempting to discuss the subject exhaustively, it is intended to give sufficiently detailed instruction, drawn from the best sources, to enable the intelligent operator to produce good results.

The Light Screen.—The light reflected from the object to be reproduced is passed through a colored glass screen before falling upon the sensitive plate, in order to equalize the chemical action of different colored rays. The shade and depth of color of this screen are somewhat varied to adapt it to special needs. The color in most common use is yellow, but the color is often modified to suit the prevailing tints of the object to be reproduced. In many cases a slight tinge of red, blue, or green is advisable. Such screens are easily prepared by coating a piece of clean plate-glass, free from scratches and bubbles, with a plain collodion, to which sufficient of some yellow dye has been added to impart the desired tint—aurantia or dimethyl orange and tincture of Bengal curcuma answer well for this purpose.

Ives prefers to use a plate-glass cell, filled with a solution of bichromate of potash.

Some experimenters strip the colored collodion film from the glass, cut it to the size and shape of the lens, and mount it with the lens in the tube. The screen may be placed in front of or behind the lens. In many cases, especially where the object is lighted by yellow light, the screen may be dispensed with.

The use of the screen materially lengthens the time of exposure, which can only be learned by practice.

Color-Sensitive Gelatine Emulsion.—Gelatine emulsion may be made color-sensitive by the addition of eight drops of a one to 500 eosine solution to every three and a half drams of emulsion. Cyanine, erythrosine, chinoline, or other dyes may be used.

Color-Sensitive Bath-Plates.—Tailfer, in France; Schumann, Angerer, in Austria; Ives, Bierstadt and Ehrmann, in America, were the first to demonstrate the possibility of rendering ordinary gelatine plates color-sensitive by immersion in a bath of the dye-stuff.

This method is superior to the older one of adding the dye to the emulsion, and it is, therefore, to be preferred, both on account of its simplicity, certainty, and a general excellence.

Scolik's Method, with Erythrosine.—

1.—Preparatory Bath.

Water	7 ounces
Ammonia	35 drops

The plates are immersed for two minutes in this bath, to secure an even action of the color-bath, and to increase sensitiveness.

2.—Color Bath.

Erythrosine solution (one to one thousand)	7 drams
Ammonia	1 dram
Distilled water	6¼ ounces

The plates are bathed in this solution from sixty to ninety seconds, rocking the tray gently.

They are then dried in the dark. These two baths are sufficient for one dozen plates, but fifteen drops of ammonia must be added to each bath after seven or eight plates have been treated. Exposure through the yellow screen is from three to six times that necessary with the original emulsion.

If the plates are very rapid, the amount of ammonia in both baths should be diminished one-half.

For portraits the yellow screen is unnecessary, unless blue or red appear in the draperies.

The addition of a few drops of a one to five hundred eosine solution to the erythrosine bath will increase the sensitiveness to red.

Prof. Ehrmann's Formulæ.—

1.—The Preliminary Bath.

Ammonia	1 dram
Water	7 ounces

2.—The Color Bath.

Erythrosine	1½ drams
Ammonia	2 drams
Distilled water	5½ ounces

The plates are bathed as before.

*Vogel's Method with Azaline**.—Sensitive to red.

Azaline alcoholic solution (1 to 2,500)	340 drops
Ammonia	34 drops
Water	22⅔ drams

The plates are bathed for one minute and then dried. A yellow screen is used, and the exposure is three or four times as long as with wet plates.

These plates will keep from four to six weeks.

Obernetter and Vogel's Erythrosine Bath.—Sensitive to yellow; good for landscapes containing much green and blue.

Erythrosine, aqueous solution (1 to 1,000)	14 drams
Silver solution (1 to 1,000)	14 drams
Ammonia	34 drops
Water	3½ ounces

The solution is filtered, and the plates are bathed in it for one minute, and then dried.

Exposure is made through the yellow screen.

The plates will keep one week.

Development is effected in the following:

1.	Sulphite of soda	3 ounces
	Pyro	3½ drams
	Water	17½ ounces

* According to Mallmann and Scolik's analysis, azaline is a compound of chinoline red and chinoline blue (cyanine), 500 c. c. m. containing one gramme of red and one decigramme of blue.

2. Carbonate of soda..... 1½ ounces
Water..... .....35 ounces

Mix one volume of No. 1 with two volumes of No. 2.

Schumann's Method with Cyanine.—

1.—Preliminary Bath.

Water.....7 ounces
Ammonia.... .....½ to 1 dram

2.—Color Bath.

Distilled water..... ... 7 ounces
Alcohol..... 3 drams
Ammonia.....68 drops
Alcoholic solution of cyanine (1 to 500)..... 3 drams

Immerse the plates for two or three minutes in No. 1, and then treat with No. 2 for ninety seconds.

Expose through the yellow screen, and develop with the following:

1. Sulphite of soda..... 6 drams
Sulphuric acid..... 8 drops
Pyro..... 2 drams
Water..... 3½ ounces

2. Carbonate of potash..... 3 drams
Sulphite of soda ..... 6 drams
Water..... 7 ounces

Start development with the following weak developer:

Solution No. 1..... .....6 drops
Solution No. 2.....6 drops
Bromide of potassium solution (1 to 10).....1 drop
Water..... .....2 ounces

adding more pyro, if necessary.

Obernetter's Method with Fluoride of Silver.—The plates are washed with distilled water for one minute, then drained and covered one minute with a solution of fluoride of silver (1 to 2,000). They are next washed slightly under a tap, and the following solution flowed over them three times, in different directions:

Erythrosine solution (1 to 1,000)..... 7 drams
Azaline solution (1 to 2,000).... .....35 drops
Carbonate of ammonia solution (1 to 6).....14 drams
Water..... .....35 ounces

The plates are then drained and dried.

No yellow screen is necessary with these plates.

The alkaline pyro developer is to be preferred.

If the plates fog in the developer, the usual bromide of potassium restrainer must be used.

Wellington's Method.—The plates are immersed for two minutes in the following bath, then rinsed and dried:

Nitrate of silver	20 grains
Carbonate of ammonia	90 grains
Erythrosine solution (1 to 500)	10 drams
Distilled water	16 ounces

To avoid fog the exposed plates are immersed for twenty seconds before development in the following bath:

Bromide of potassium	120 grains
Ammonia	4 drams
Water	10 ounces

Then well rinsed and developed with any good developer.

The use of the yellow screen is unnecessary if the exposures are to be made by gas or lamp-light. For day-light exposures the screen must be used if the object to be copied contains much blue.

The interesting feature about the two last-mentioned methods is that they seem to disprove the commonly accepted absorption theory, according to which the function of the various dyes is to act simply as optical sensitizers, by increasing the absorption power of the film for certain colors.

But the fluoride and carbonate of silver processes seem to prove that the orthochromatic effect is due rather to a chemical change, produced by the presence of free silver and a new compound formed with dye.

The theory is now meeting with general adoption, and it makes the function of the dye, in combination with a sensitive silver haloid, that of a color-screen merely, each dye acting according to its color or shade of color.

The fact that Ducos du Hauron and Edward Bierstadt have been able to secure good orthochromatic effects by exposing ordinary collodion or gelatine plates through variously colored

glasses, or cells, filled with colored liquids, seems an additional argument in support of this theory.

Development.—The use of color-sensitive plates necessitates no changes in the ordinary process of development, which may be effected with oxalate of iron or the alkaline developer.

Great care must be taken not to expose the plates to the direct rays of the dark-room light, until development is well started.

Schumann and Eder recommend the use of three thicknesses of brown tissue-paper as a safe medium through which to filter the light.

Eder's Method of Developing Color-Sensitive Plates.—Dr. Eder prefers the oxalate of iron developer, and begins development with an old developer. A properly-exposed plate should show all the details in from five to ten minutes, but the image will probably be weak. In this case it is necessary to add to the old developer one-half, or an equal bulk of freshly mixed developer, and to prolong the development ten minutes.

In some cases the development must be continued for thirty minutes. Slowly developed negatives give the best results.

Angerer, Scolik, Schumann, Ehrmann, and others, prefer the potash developer for the development of color-sensitive plates.

Captain Abney has recently made the discovery that all that is necessary to render any plate color-sensitive is to coat it with a solution of the dye (eosine, cyanine, etc.), in alcohol or collodion. The action of light taking place at the surface of the plate, it is said to be sufficient to have the dye in contact with the surface molecules only.

Coming from so high an authority, the new method is presumably practical; but further knowledge of the results is necessary before accepting it as a rival of older and well-tried methods.

CHAPTER XVI.

BLACK AND WHITE NEGATIVES.

Most of the mechanical printing processes require negatives of greater density than is necessary or desirable in negatives used solely for printing upon sensitized paper.

All the details of lines or lettering must be reproduced with perfect sharpness in the negative, the high lights being intensely black to prevent the light from penetrating through on to the bichromatized gelatine plate beneath. Such negatives are technically known as "black and white negatives."

The favorite process for the production of this class of work has long been, and still is, wet collodion. Undoubtedly it is possible to produce negatives of abnormal density on gelatine plates, as will be described later in the chapter, but the wet collodion, in the opinion of those most skilled in this class of work, offers greater facilities in working, and produces better and more uniform results.

The directions given in the following pages are based on articles on this subject which appeared in *The Photographic Times.*

Wet Collodion Process.—While any good collodion may be used, the following is especially recommended:

Alcohol	5 ounces
Ether	5 ounces
Iodide of ammonium	50 grains
Bromide of ammonium	20 grains
Pyroxyline	50 grains

The silver bath should be acidulated with acetic acid, which is better suited to vigorous development, and decreases the likelihood of a foggy deposit upon the clear portions of the negative.

The plates are collodionized and sensitized as usual.

The time of exposure is a factor of great importance in this class of work. If the plate is under-exposed, the lines will be rough and heavy. If over-exposed the fine lines or stipple are blocked up. A correctly exposed plate shows the finest lines only feebly.

The development should not require longer than three or four minutes, or the negative will suffer. The following developer gives good results:

Water	16 ounces
Sulphate of iron	1 ounce
Acetic acid	1 ounce

to which 1 dram of sulphate of copper may be added to give more solidity to the deposit.

The negative, after development, should be rather thin, and will need to be intensified. The best and safest method is that of Dr. Eder, with nitrate of lead.

The negative, after fixing and a thorough washing, is immersed in the following bath:

Nitrate of lead	2 ounces
Red prussiate of potash	3 ounces
Water	50 ounces

The bath must be filtered.

In this bath the color of the negative soon changes to a yellowish-white, which must be allowed to deepen until the proper degree of density is reached.

The chemical action of this bath is thus explained. The silver in the image acts as a reducing agent, and deoxidizes the ferri-cyanide to ferro-cyanide, which unites with the nitrate of lead to form the insoluble ferro-cyanide of lead.

After being removed from the lead bath the negative is washed until the drainings give no blue precipitate when the sulphate of iron is added. It is then blackened by immersion in a 1 to 6 solution of hydro-sulphate of ammonia. The action of this bath is continued until the film is black on both sides. The negative is then well washed, and should show great clearness in the lights, and great density in the ground.

If sufficient density was not conferred by the lead bath, the negative may be whitened in a 1 to 10 sulphate of cadmium solution, then washed and blackened as before with ammonia, which transforms lead, cadmium, and silver into the corresponding sulphides.

Yellow fog or stains are due to insufficient washing after fixing, but they can be removed by flooding the plate with a sherry-colored solution of iodine and iodide of potassium, followed by fixing in a weak cyanide of potassium bath.

Negatives properly intensified with nitrate of lead, are wonderfully clear in the lines, of great density, and produce fine and high reliefs on bichromatized gelatine.

Stripping.—Negatives intensified with lead are stripped by coating the films first with a 5 grain solution of pure india-rubber in benzine, and then with a tough plain collodion. When dry the edges of the film are cut through to the glass, and the plate immersed in 1 to 10 acetic acid solution. The film soon loosens, and may then be detached from the plate.

Gelatine Process.—The great convenience attending the use of gelatine emulsion plates has led to many experiments for the purpose of giving the negatives on gelatine films the qualities necessary for mechanical printing.

For this purpose plates of a low order of sensitiveness are correctly exposed, and developed with the oxalate of iron developer, to each eight ounces, of which have been added fifty drops of the following solution:

Iodine	10 grains
Iodide of potassium	10 grains
Water	3 ounces

As soon as the image appears, a small quantity of the bromide of potassium restrainer should be added.

Properly exposed plates thus developed will need no intensification.

If the negatives are not sufficiently intense they may be strengthened by whitening the films in the following bath:

Chloride of ammonium	16 grains
Bichloride of mercury	1 dram
Water	24 ounces

The negatives are then most thoroughly washed and treated with the following:

Cyanide of potassium	30 grains
Iodide of potassium	15 grains
Bichloride of mercury	15 grains
Water	7 ounces

After reaching a certain degree of density in this bath the reducing power of the cyanide begins to show itself, and the density is thus reduced. By taking advantage of this fact the operator can easily determine the character of the negative.

CHAPTER XVII.

INSTANTANEOUS PHOTOGRAPHY.

The time of exposure necessary to imprint a developable image on the sensitive surface, has been reduced to the one twenty-six-hundredth part of a second, and even lower, under exceptionally favorable circumstances.

This great increase in sensitiveness has opened a new and delightful field to the photographer, making it possible for him to give graphic delineations to fleeting effects of motion, expression, and grouping, which but lately were impossible of exact and accurate delineation.

The detective camera has become a necessary part of the photographic outfit, and the tourist who is provided with one of these modern instruments, finds little difficulty in securing interesting studies of the lands and peoples visited by him.

But instantaneous photography, with detective cameras and highly sensitive plates, is not so certain as the more common method of longer exposures on slower plates.

If the development of a correctly-timed exposure is a delicate operation, much more delicate is it to coax a good printing image from a plate which has received an exposure of only a fraction of a second.

It is, however, but a transfer of difficulties and perplexities from one stage of the process to another. In the case of a timed exposure the operator's judgment is most exercised to determine the length of exposure best suited to the view before him.

With instantaneous exposures, however, it is in development that good judgment is most needed to make the most possible out of the plate.

He who would be successful in instantaneous work must

have a thorough knowledge of the plate used, the distance and illumination of the object, and the conditions of development.

It is taken for granted that the plates used have at least as high a sensitometer number as 25, which is rapid enough for most purposes, and even in the detective camera they are more often over than under-exposed, owing to the use of a diaphragm with too large an opening.

The distance and illumination of the object determine the amount of light to be admitted, and, consequently, the size of the diaphragm and the speed of the shutter.

Objects near at hand require the admission of more light than those at a distance, because their actinic force is distributed over a larger area of sensitive surface.

If the illumination is from behind the camera, a smaller diaphragm may be employed than when the shadows fall transversely across the field.

Objects in shadow will require a larger diaphragm than those fully illuminated.

In general it may be said that the best effects, both as regards definition and tone, are secured by using a medium-sized diaphragm and increasing or diminishing the speed of the shutter.

The following table is given as the results of the author's experiments with a Morrison lens of 8-inch focus, using No. 25 plates.

For brightly-illuminated landscapes, with rapid shutter, use diaphragm opening $\frac{f}{16}$.

For seascapes, with quick shutter, use $\frac{f}{20}$.

For figures, animals, etc., in the foreground, use $\frac{f}{12}$, with moderate speed.

For thick foregrounds, with foliage in the middle distance, use full opening, with fair speed of shutter, or, for better definition, $\frac{f}{12}$, with slower shutter.

For buildings and confined scenes generally, when well illuminated, use $\frac{f}{12}$, with moderate speed.

These may be taken as standard measurements, and the resulting exposures, if properly developed, will yield negatives with sufficient pluck to print well.

Development.—Instantaneously exposed plates should be developed slowly, using a developer weak in pyro and alkali, and the plate should be protected from the action of the light.

The following method is given, not as the best or only possible one, but as the one which has given the author uniformly good results.

The developer is compounded as follows:

No. 1.

Pyro	1 ounce
Sulphite of soda	1 ounce
Sulphuric acid	10 drops
Water	10 ounces

Dissolve the soda first, then the pyro, and then add the sulphuric acid.

No. 2.

Carbonate of potash	1 ounce
Sulphite of soda	1 ounce
Water	10 ounces

One dram of each of these solutions contains six grains of pyro, sulphite and carbonate.

To develop.—Take

Water	4 ounces
Solution No. 1	1 dram
Solution No. 2	1 dram

Immerse the plate in this and cover the tray with an opaque screen. If after two or three minutes the high lights do not appear, add half a dram of No. 2. As much as four drams of No. 2 can be added without producing fog, but in most cases two to three drams will be found sufficient.

As soon as the details are well out, add one dram of No. 1, and continue the development until the image is visible at the back of the plate. Instantaneous exposures seem to lose more density in the fixing-bath than timed exposures, therefore they should be developed further.

If, after the addition of two drams of No. 2, the details still hang back, do not seek to hasten matters by the addition of more alkali, but dilute the developer one-half with water, or

remove the plate from the tray and immerse in a weak alkaline solution (one dram of No. 2 to four ounces of water) until the details appear, then return to the developer to which the second dram of No. 1 has been added.

It will generally be advisable to give the plates a preliminary soaking for two or three minutes in the weak alkaline solution, given above, before applying the developer. This method is valuable in the case of heavy foliage and dark shadows.

If the image flashes up immediately, add a few drops of a ten per cent. solution of bromide of potassium.

The following method of developing instantaneous exposures with Beach's formula, given on page 121, is taken from the *Photographic Times.*

"Take of solution No. 1, or pyro, 45 or 50 minims, and mix with 3 fluid ounces of water, not too cold—about 60 deg. in summer and 70 deg. in winter is most satisfactory. Add 30 minims of the No. 2, or potash, solution, and flood the plate without previous soaking in water. Have at hand, in soak in a basin of clean running water, a wide camel's-hair brush, such as is commonly sold for dusting off plates, and with it lightly brush the surface of the plate under the liquid, to prevent air-bells and pin-holes. The picture will come up slowly and steadily, and should be pushed to considerable density, until the outlines begin to "sink in." When the plate is held up to the red light, the dark parts should be of an opaque, velvety black, and a dim, but clear, ruddy glow ought to shine through the lighter details. Looked at on the wrong side, the image should be discernible. It is safer to press the development a trifle too far than to halt too soon, for it is always easy to reduce an over-developed plate, but in practice there is not much likelihood of over-intensity in a well-timed instantaneous plate, for it loses density prodigiously in fixing. Wash well before fixing, and when the whiteness goes off, transfer to a cool bath of fresh hyposulphite, and let it soak for a few minutes longer.

It sometimes happens that, even with this weak developer, the image comes up too rapidly, giving full details while den-

sity lags. In such cases, add half a dram more of the pyro-gallol mixture and ten or fifteen drops of the following solution:

Water	4 ounces
Sodium sulphite	1 ounce (437 grains)
Sodium carbonate (chem. pure, *dry*)	1 ounce (437 grains)
Ammonium bromide	20 grains

On the other hand, if the image shows undesirable contrast and backwardness in the details, the developer should be further diluted with an ounce of water, and ten, or even twenty, drops of the standard No. 2 (potash) solution added."

The careful study of these two methods will enable the intelligent operator to employ any alkaline developer for the development of instantaneous exposures.

CHAPTER XVIII.

TOUCHING UP THE NEGATIVE.

Negatives are rarely perfect in every respect when finished. There is often a want of harmony, frequently an overabundance of pin-holes. These and various other defects necessitate judicious doctoring before good prints can be obtained.

Avoiding any discussion concerning the retouching of portrait negatives as too difficult and serious a matter to be adequately treated in a general work like the present, a few methods of improving poor negatives and remedying the defects of faulty ones will be briefly indicated in the present chapter.

A very common fault, in landscape negatives, is a want of harmonious blending of the tones; the high lights are too dense, the shadows too thin. Such a negative, if printed from without any touching up, would give very unsatisfactory prints.

The shadows must be brought up to the proper density to print well with the high lights.

A common method of securing this end is to paste tissue or tracing paper over the back of the negative, cutting out the high lights with a sharp penknife. In this way the density of the shadows is increased; the effect may be hightened by applying black lead with a stump to the parts which require it.

Another very efficient means of securing better gradation, is to coat the back of the plate with a plain collodion, to which a tinge of red or yellow has been given by the addition of aniline dyes. This method is particularly good for strengthing weak negatives, as any desired depth of color may be

given to the collodion by increasing the amount of dye added.

The author much prefers, to either of these methods, the use of the mat varnish, the formula for which is as follows:

One dram of powdered sandarac is dissolved in fourteen drams of ether, fifteen grains of Canada balsam, and five or six grains of pure benzine or benzole are then added and the varnish filtered. It is applied by flowing it over the back of the negative, which is not warmed. If one coating does not give sufficient density two or three may be given.

The advantage of this varnish is that it may be removed from the denser portions of the negative with a brush dipped in mastic varnish, and that it admits of any amount of retouching with plumbago and the stump, or with the pencil.

If desired, the varnish may be colored with aniline dye.

Pinholes, scratches, and other defects of a similar nature, should be touched up with India ink applied with a very fine brush. The ink should be used nearly dry and laid on thinly, to attain, as far as possible, the density of the surrounding parts.

Local reduction of density may be effected by rubbing the over-dense portions with a piece of fine linen drawn over the finger end and moistened with alcohol, or by mixing a small quantity of any of the reducing agents, given on page 128. with gum water, and applying the mixture with a brush.

Local intensification may be produced in the same way.

These general hints are sufficient to enable the skillful operator to improve the printing quality of defective negatives, which is their only aim.

CHAPTER XIX.

PHOTO-MICROGRAPHY.

PHOTOGRAPHY has proved a most useful handmaid to microscopy, and the photographic camera has, to a large extent, emancipated the microscopist from the camera lucida. Various methods have been devised for the photographic reproduction of the highly magnified images given by the microscope, some of the best of which have been selected for description.

Mercer's Photo-Micrographic Camera.—This instrument is so well illustrated in Fig. 30 as to require but little further explanation. It is light and portable, and can be used with the microscope in any position. It is used in connection with the eye-piece, and carries plates measuring $2\frac{3}{4}$ by $3\frac{1}{4}$ inches.

Its essential parts consist of a small box, to which is attached a brass cone provided with a draw tube for insertion into the body of the microscope. The weight rests upon the brass arm, as shown, none of it being upon the sliding parts. Coarse adjustment is made by sliding the instrument up and down on the arm; the fine adjustment is given by the micrometer screw of the microscope.

This little instrument, while not well adapted for serious scientific work, is well suited to the wants of the amateur, on account of the small cost, its simplicity, and the rapidity of its manipulation.

The Scovill Photo-Micrographic Camera.—Fig. 31 illustrates another simple form of the micrographic camera, using plates $4\frac{1}{2}$ by $5\frac{1}{2}$ inches.

It consists of an ordinary bellows camera, having a cone extension in front to give the additional length of focus necessary to give the desired amplification to the image.

To this cone the body of the microscrope, inclined horizon-

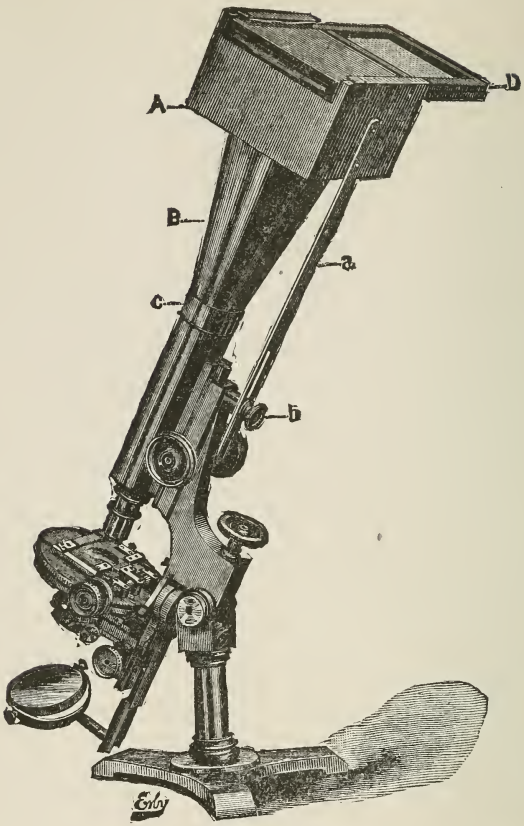

FIG. 30.

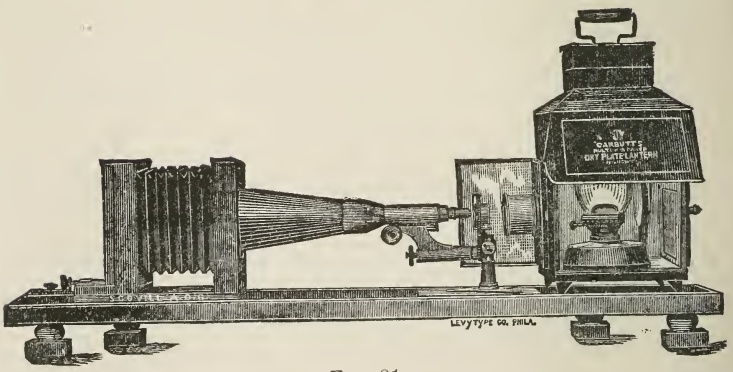

FIG. 31.

tally, is adapted by means of a black velvet sleeve. The source of illumination shown in the cut is Carbutt's multum in parvo lantern, with the condensers in place. Any other method of illumination may be substituted.

Atwood's Photo-Micrographic Camera.—Fig. 32 illustrates a very convenient form of apparatus which dispenses with the microscope body. The coarse adjustment is effected by sliding the stage upon the solid base. The sub-stage bar is on the plane of the stage, and is provided with an adjustable and centering sub-stage to hold any accessories desired. The fine adjustment is in the nose piece, a brass tube with society screw to receive any ordinary microscopic objective. The focusing is done by means of a rod passing under the box to the back and terminating in a milled head as shown. The illumination is from a lamp from behind the stage.

Amplifiers are provided to increase the size of the image thrown on the ground-glass screen. The whole apparatus is mounted upon a cherry board of convenient length.

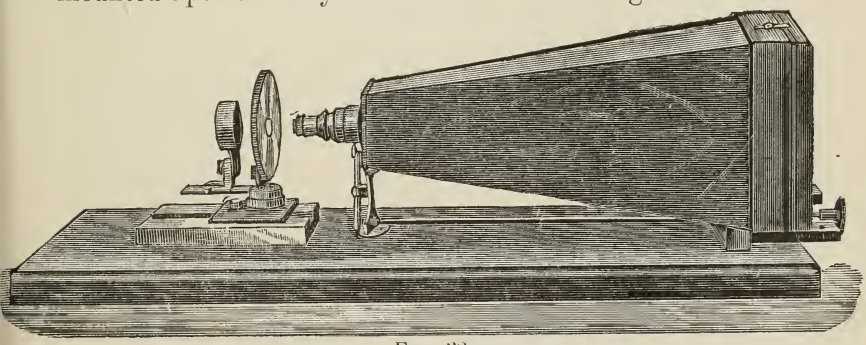

FIG. 32.

The form shown in the cut allows the use of plates 4 by 5 inches and under, but a modification has been introduced, with bellows extension, which increases the size of the image to the whole plate. Either form may be fitted with mirrors, stereoscopic and other attachments required by the varying needs of the investigator.

Walmsley's Photo-Micrographic Camera.—Figs. 33 and 34 illustrate the very complete and ingenious apparatus, devised by Mr. W. H. Walmsley, and manufactured by the American Optical Company.

Fig. 33 illustrates the original and cheaper form, adapted only to the making of negatives up to the half-plate size.

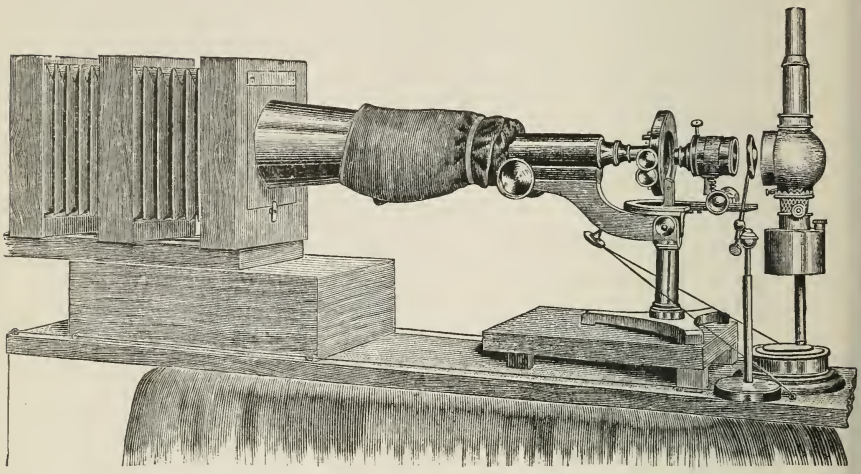

FIG. 33.

Fig. 34 shows the latest form by which the original apparatus is converted into a small enlarging, reducing, and copying camera.

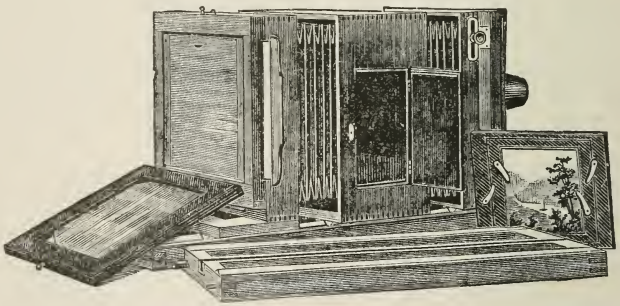

FIG. 34.

The following description of the complete camera, first published in the *Photographic Times*, is also applicable to the

cheaper form, excepting that the latter cannot be used for enlarging, reducing, or copying. In all other particulars the two boxes are identical.

"The camera box (of mahogany) is square, carrying a Flammang single plate-holder for 4¼ by 5½ plates; usable vertically or horizontally, and with kits for 3¼ by 4¼ plates. The bellows are in two sections, with a central division of mahogany, which carries a removable partition, to which a suitable rectilinear photographic lens can be attached, for enlarging, reducing, or copying. A light-tight door on one side of this wooden section gives ready access to the lens for inserting or removing diaphragms, or other necessary manipulations, whilst a milled head, accessible from the same opening, clamps the lens-bearing section firmly to the bed of the camera at any desired point.

"The bellows have an extension of two feet in addition to the length of the box, sliding very smoothly upon V-shaped ways, which, for greater convenience, are made in two sections, firmly attached to each other by wooden dowels and a solid brass screw, worked by a milled head.

"The bellows are firmly held at any desired point of extension by a cam, operated by a lever conveniently placed at the rear of the focusing screen, which latter is hinged at the bottom, and, when not in use, lies out of the way upon the extension bed. The screen itself is of the very finest ground-glass, but is used only for arranging the portion of the object to be photographed properly in the center of the plate, as no surface can be ground finely enough to permit the sharp focusing of any delicately-lined object. For this purpose, a circle or disc of thin microscopic covering-glass is attached with balsam to the center of the ground-glass screen, which clears away all the inequalities of the latter, and leaves an exquisitely fine surface to receive the image, which, by using an ordinary focusing glass, may be as sharply defined as in the eye-piece of the microscope.

"The front of the camera (which is double-shifting, for the purpose of centering) carries a cone-shaped tube, which receives the tube of the microscope when the latter is inclined

to a horizontal position, and conveys the image-bearing rays of the light therefrom into the body of the camera. This cone is removable, and in its place may be inserted kits, carrying negatives from quarter to half size for enlargement, or reduction to lantern slides, as may be desired. Or a front board, bearing a lens, may be inserted in its place, converting the camera into a copying one. Indeed, a more complete instrument for all the purposes for which it was devised could scarcely be conceived or desired. Its design was the result of several years' work and experiment on the part of Mr. Walmsley; and the Scovill Manufacturing Company have carried out his plans in their usual masterly manner, leaving nothing to be desired.

"In use, the camera is attached to a solid platform (which also carries the microscope and lamp) by a screw, such as is used with an ordinary tripod. By this means any jar or tremor, produced by a passing vehicle or other means, is communicated to microscope and camera alike, preventing any diminution of sharpness in the negative. By this arrangement, also, the whole apparatus is so compact that, with the bellows closed, the operator can easily see the image upon the ground glass, and at the same time reach the milled heads upon the microscope controlling the stage and focusing movements, permitting the arrangement of the subject with the greatest nicety. But, when the bellows are extended to their full length, some appliance becomes necessary to operate the fine adjustment of focus, whilst the eye can discern the changes upon the screen. This is most simply effected by Mr. Walmsley, in the employment of a fine cord passing in a groove around the periphery of the milled head of the fine adjustment screw, and thence through a series of hook-eyes to the rear of the camera bed, where it is held taut by a couple of leaden weights. The slightest pull upon either cord moves the fine adjustment screw with the utmost nicety."

Nothing more complete or convenient than this apparatus can well be devised. By its use no difficulty will be experienced in securing by lamp-light photo-micrographs of all transparent objects requiring microscopical examination. Opaque

bodies may be photographed by illuminating them by sunlight reflected from a mirror.

White's Photo-Micrographic Apparatus.—Fig. 35 is an

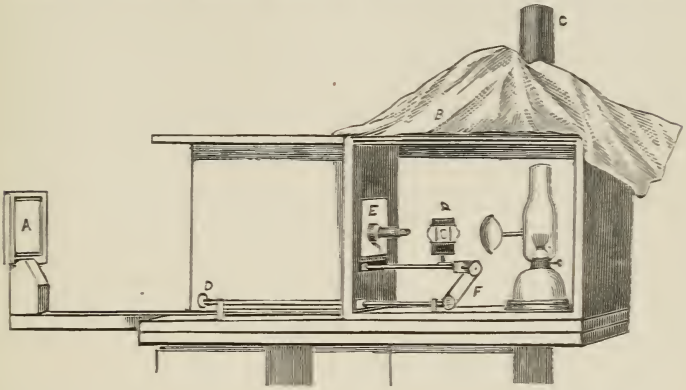

FIG. 35.

illustration of a novel piece of apparatus, which dispenses with the use of the microscope, and projects a magnified image of the object upon a movable screen. It is the invention of Mr. T. Charters White, of England, who claims for it the following advantages: That the field of view is only limited by the size of plate employed; that a great range of amplification is possible, and the ease with which all the adjustments are made.

The following description of the construction and method of working is condensed from that given by Mr. White in the "British Journal Almanac, for 1887."

A narrow, lidless box is fastened by screws to one end of a baseboard, two inches in thickness, and two and a half feet in length. The other end of the baseboard is provided with a groove, in which slides the wooden bar which carries the frame which holds the focusing screen and sensitive plates. An ordinary printing frame answers well for this purpose. An oblong opening is cut in the top of the box over which a metal chimney is fitted.

In the end of the box, facing the plate-holder, a square opening is cut and closed with a brass plate tapped with the standard screw gauge, thus allowing the use of any standard

objective. The movable stage support is fastened to the end of the box, below the brass plate, the stage being moved to and from the objective by a long micrometer screw. The front of the box is covered with a black velvet curtain.

Two focusing screens are used; one, for coarse adjustment, is made by gumming a sheet of smooth white paper on a glass plate. This is placed in the holder, and the object roughly arranged and focused. The screen is then removed, and a piece of plain glass substituted for it, having fine lines, drawn close together with a writing diamond, on the surface which faces the object. These lines are brought into the focus of a focusing glass, placed against the back of the glass, and the stage moved back and forth until the details of the object are seen with equal sharpness. The glass is then removed and the sensitive plate substituted for it.

This apparatus presents some novel features, and seems well adapted to the photographing of transparent objects. Of course all white light must be excluded from the room while the sensitive plate is in position, save that which comes through the objective.

Apparatus for the Vertical Microscope.—It is sometimes necessary, or desirable to retain the microscope in the vertical position. Such an arrangement is shown in Fig. 36, the microscope being omitted as unnecessary to the clearness of the description.

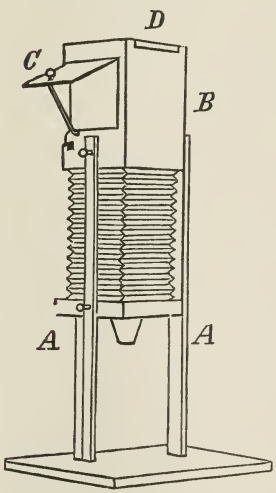

FIG. 36.

A A, are slotted bars supporting the camera body, B, with its bellows. There are three of these bars fastened firmly to a slab of hard-wood, as shown in the cut. The box, B, carries the ground glass frame, D, at its upper end, and is provided with a door, C, in one side. The object of this door is to admit of focusing, without mounting a step-ladder. It must fit light-tight.

The microscope is adapted to the cone in the base of the instrument by means of a velvet sleeve.

There are many other ways of securing photographic representations of the images seen in the microscope, but they are all modifications of the various arrangements just described, which are believed to be sufficiently varied to meet all possible needs.

It is now proposed to enter somewhat fully into the practical manipulations of photo-micrography, and to give some hints on the choice of the microscope and objectives.

The Microscope.—Any standard form of microscope, binocular or monocular, may be employed; the body should be capable of being included to the horizontal position. The best form for photo-micrography is one with a broad short tube, because the field of illumination is then less restricted than when a long tube is employed. If the binocular stand be used, the prism must be withdrawn sufficiently to allow all the light to pass through the straight tube.

The eye-piece may be used, or not, as the operator prefers. If it is not used, the tube must be lined with some soft dark material, to prevent reflections which cause spectral spots called "ghosts," in the negatives.

A mechanical stage, revolving in the optical axis of the microscope, a sub-stage revolving in the plane of the stage, a condenser, and a double or triple nose-piece will be found necessary for serious work.

The latter is especially necessary when working with high powers, as an object can be quickly brought into proper position under a low power, and the high power substituted by revolving the nose-piece.

The Objectives.—The experimenter is recommended to begin with the low powers, and to attempt higher powers only after he has gained complete mastery over the manipulations with the low powers. The one-half inch objective is a very good power to begin with, and the one-eighth inch is about as high as can be worked in photo-micrography, although much depends upon the skill of the operator.

When working by artificial light with low powers, no difficulty will commonly be experienced through want of coincidence between the chemical and visual foci. With higher

powers, however, it is necessary to determine the difference by actual experiment and allowed for it in focusing, or specially corrected objectives, may be employed. The photo-micrographic series of the Bausch Lomb Company, of Rochester, are free from this defect, besides giving a very flat field and fine definition.

Source of Light.—The object to be photographed may be illuminated by sunlight or artificial light, the latter being preferred on account of its greater certainty and uniformity. Any good microscopic lamp, burning oil, will answer well for photo-micrographic work, and a little practice will enable the operator to make such simple arrangements as may be necessary to secure the best results. The usual practice is to place the lamp behind the object and in line with it. Some operators, however, prefer to illuminate the object by means of light reflected from a white screen placed behind the stage.

With objectives of low powers, condensers will not be needed; they must, however, be used when working with the higher powers, which require the most careful adjustments and the most scrupulous attention to minute details, and which are, therefore, not recommended except to the most advanced manipulators.

If lamps with flat wicks are used, the flame must be placed at an angle to the plane of the stage, in order to avoid the dark spot in the center of the field. Even illumination of the object must be secured by the use of the diaphragms with which the stage should be provided.

The author believes that the incandescent electric light is superior to the oil lamp, as it occupies less space, gives out no heat, and can be adapted to the revolving sub-stage bar. A very efficient light of this kind is manufactured by the Bausch & Lomb Company.

Measuring the Magnification.—The scientific value of a photo-micrographic print is greatly increased if its exact magnification is indicated.

This is easily effected by placing upon the stage a micrometer ruled in $\frac{1}{100}$ and $\frac{1}{1000}$ of an inch, and focussing its image upon the ground-glass. The exact value of each division is then readily determined.

To avoid the necessity of making this measurement each time an object is to be photographed, it is well to make the measurements at various points in the extension of the bellows, and to mark those points with their exact power of magnification.

The Sensitive Plates.—The nature of the work to be done will determine the kind of plate to be employed. For micrometric purposes, where the greatest precision is absolutely necessary, collodion films are to be preferred to gelatine films, because their distortion is less, being not more than 2 or 3 in 1000 parts, while gelatine films often show an error of 1 in 100 parts.

For studying details, however, gelatine is vastly superior to collodion. The method of preparation must have been such as to combine extreme sensitiveness with density and strong contrasts. Abney states that the best plates for this class of work are those prepared with iodide of silver, by boiling, and without the use of ammonia.

For colored objects the use of color-sensitive plates in connection with the yellow screen is strongly advised.

Plates coated with Davanne's emulsion, given on page 102, are well adapted to photo-micrographic work.

Focusing.—For arranging the object in the field, and for the preliminary focusing the ground-glass is used. For the final focusing the ground-glass is replaced by a plain glass, on whose inner surface a series of fine parallel lines have been drawn with a writing diamond. The focus of a focusing-glass placed against the back of the glass plate is adjusted to render these lines sharp and distinct. The image is then brought into focus, and the exposure made.

Exposure.—The time of exposure varies according to the nature and color of the objects, the power of the objective, and the nature of the illumination. Mr. Walmsley gives the following table for the different powers with the oil lamp:

1½ inch	3 to 45 seconds
1 inch	5 to 60 seconds
⅝ inch	¼ to 1½ minutes
$\frac{4}{10}$ inch	½ to 3 minutes
⅙ inch	2 to 7 minutes
$\frac{1}{10}$ inch	5 to 10 minutes

These figures, however, are only approximate, and the operator must learn from experience here as in other departments of photography.

Development.—Any form of developer may be used, either the oxalate of iron or the alkaline. It is best to develop more for detail than for density, resorting to intensification, if necessary, to bring the negative up to the proper printing density.

CHAPTER XX.

MICRO-PHOTOGRAPHY.

The term micro-photography has been applied to the production, on a scale of microscopic fineness, of positives on glass from large negatives. These positives are subsequently mounted at one extremity of a Stanhope lens of great magnifying powers and enclosed in many ways in tiny opera-glasses, keys, penholders, medallions, etc., and sold as curiosities.

The process by which these microscopic pictures are produced is little known and rarely practised. To the best of the writer's knowledge, there is but one producer of these articles in America, and his methods are not known to the author.

The method here given is that employed by the best French producers of micro-positives, and is described in all its details to enable the experimenter to produce good results.

A negative is first made, on a whole plate, of the object to be reproduced. This negative should not be made over-dense, as it is to be used in the copying camera for the reproduction of the reduced positives. It is not to be varnished, but when dry it is copied by any method known to the operator, the usual copying lens being replaced by a brass plate carrying from twenty-five to fifty very small objectives, as shown in Fig. 37, which shows only a few of the objectives.

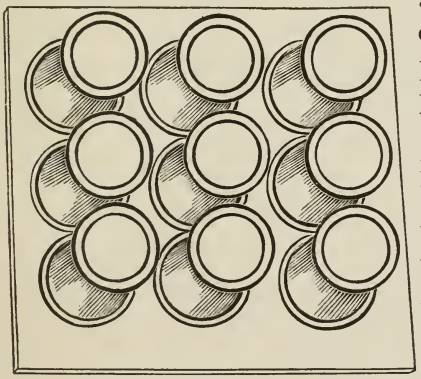

Fig. 37.

This apparatus is known as the microscopic apparatus, and can be obtained of most large dealers in photographic goods.

It will give fifty reduced positives on a 2x2½ inch plate. Therefore, by using a 4x5 plate, and a holder adapted for making two exposures on one plate, one hundred impressions may be taken without changing the plate.

A piece of ground-glass is placed behind the negative to be copied, which is accurately focused on the ground-glass at the back of the copying camera, using for this purpose a powerful focusing glass.

The exposure is made as usual, and the plates developed in the customary manner.

Since, owing to the small size of the image, it is manifestly impossible to watch the progress of development very closely, a few trial exposures must be made, developed, and fixed, that the operator may acquire a knowledge of the proper duration of the exposure, the correct strength of the developer, and the time of development.

After development, the plates are fixed, washed, and dried, and then varnished with the following varnish:

Benzoin	220 grains.
Alcohol	3½ ounces.

They are then laid face down on a clean sheet of white paper, and cut in parallel lines with a diamond between the positives, which are then separated from each other, after which they are mounted.

Mounting.—For this purpose a table with a sheet-iron top is needed. The edges of the top are turned up to form a tray, which is filled with fine sand, over which is spread a piece of thick black cloth, on which are placed the Stanhopes and the positives, with the side bearing the images uppermost.

The sand is kept warm by means of a spirit or oil-lamp. A jar of Canada balsam, previously warmed, a pair of small brass pliers, and a small, flat stick of wood are also placed within convenient reach.

One of the lenses is taken with the right hand between the pliers, and a small quantity of the balsam applied to its flat end, which is then placed upon one of the small images, after which it is set aside to cool. When cool, the edges of the

positives are rounded off on a grindstone, and then covered as desired.

Wet collodion plates are best suited for this purpose, owing to the liability of gelatine film sustaining some damage when the plates are cut down.

Although these micro-positives are chiefly used as curious ornaments, they have a more serious value, as affording means for the storage in small space of reduced copies of valuable originals, and for the reproduction of reduced maps, charts, etc , for the tourist's use.

CHAPTER XXI.

THE TRANSFORMATION OF NEGATIVES INTO POSITIVES.

MANY heliographic processes require a positive for the production of the printing plate, as does also the production of enlarged negatives. Many methods have from time to time been proposed to obviate the necessity of taking a positive direct from the negative by contact printing or by exposure in the copying camera.

Methods have also been worked out for producing positives direct in the camera, but all these methods have proved too uncertain to come into general use.

M. Roux, a skilful French manipulator, has worked out a practical process for the chemical transformation of negatives into positives, which should prove valuable to the process worker.

All essential details of the process are given in the present chapter.

No. 1.—*Collodion for Drawings and Engravings.*

PLAIN COLLODION.

a.	Ether	21½ ounces.
	Alcohol	10¾ ounces
	Pyroxyline	150 grains

IODIZER.

b.	Alcohol	2¾ ounces
	Iodide of potassium	123 grains
	Iodide of cadmium	30 grains
	Iodine	0.7 grains
	Chloride of zinc	30 grains

2.—*Collodion for Half-tones.*

PLAIN COLLODION.

a. Same as above.

IODIZER.

b.	Alcohol	3¾ ounces
	Iodide of cadmium	92 grains
	Iodide of ammonium	30 grains
	Iodide of zinc	30 grains
	Bromide of cadmium	22 grains
	Bromide of ammonium	22 grains
	Chloride of zinc	30 grains

THE SENSITIZING BATH.

Distilled water	35 ounces
Nitrate of silver	1234 grains
Acetic acid	1¾ ounces

The plates are sensitized as usual, and dried moderately.

Exposure.—For negatives which are to be transformed, the exposure should be a trifle longer than would be necessary for an ordinary negative.

Development.—The following developer is recommended by M. Roux:

Water	35 ounces
Sulphate of iron	770 grains
Acetic acid	1⅞ ounces
Alcohol	1⅞ ounces
Nitric acid	30 drops
Ammonia	30 drops

The best method of preparing the developer is to pulverize the sulphate, then to add the nitric acid, and, after stirring, the ammonia. The iron turns black, and stifling fumes are given off. As soon as these cease, the water is added, and, finally, the alcohol and the acetic acid.

Negatives developed in this bath are strong and brilliant, with good printing density. For the present purpose, however, it is necessary to intensify them slightly, after washing off the developer, with the following:

Water	35 ounces
Pyrogallic acid	77 grains
Citric acid	385 grains
Alcohol	3 drams

to a sufficient quantity of which are added, when wanted for use, a few drops of the following:

Distilled water	35 ounces
Nitrate of silver	308 grains
Acetic acid	1⅞ ounces

After intensification, the negative is washed slightly, but not sufficiently to remove all the free nitrate, a slight excess of which is useful in determining the formation of the positive image during the latter exposure to diffused light.

The Transformation of the Negative.—Two operations are necessary to transform the negative into a positive:

1. Exposure of the *unfixed* negative to diffused light.

2. Destruction of the negative image by dissolving the reduced silver, and development of the positive image.

1.—*Exposure to Diffused Light.*—The unfixed negative is placed, face up, on a piece of black cloth, and exposed to weak diffused light until the positive image viewed by the reflected light is clearly seen with a bluish-black tone on the grey ground of the silver of the negative image. The time necessary to produce this effect will vary from a few seconds to two or three minutes, according to the strength of the light.

The color of the positive image is due to the presence of a small quantity of chloride of silver.

2.—*Destruction of the Negative Image, and Development of the Positive.*—If re-development followed immediately upon the exposure to diffused light, the two images would be confused together. Hence it is first necessary to destroy the negative image. This is done by placing the plate, after washing slightly, in the following solution:

Water	25 ounces
Bichromate of potash	460 grains
Nitric acid	10½ ounces

The plate is immersed in this bath until the reduced silver of the negative image is entirely dissolved; that is, until the film assumes a yellow color, except in the lines of the positive, which will strike a slightly reddish tint, owing to the formation of chromate of silver.

The plate is then washed until all traces of the acid are removed.

The positive image is then developed by pouring over the plate sufficient of the following:

Water	35 ounces
Pyrogallic acid	385 grains
Citric acid	308 grains
Alcohol	1⅞ ounces.

This solution is allowed to remain on the plate for a few seconds; it is then poured off into a graduate containing a few drops of aceto-nitrate of silver solution, given above, and the mixture poured back on the plate.

The positive image will now gradually develop with a strength proportioned to the amount of silver added to the developer. Reproductions of line-work require a strong and rapid development in order to preserve the fineness of the lines and perfect transparency of the ground. Reproductions of portraits, landscapes, and paintings require slow development with little silver to preserve the gradations of the half-tones.

Fixing.—The developed positive is fixed as usual, reproductions of line-work, preferably in a 1 to 50 solution of cyanide of potassium; those in which it is desired to preserve the half-tones, in the usual hypo solution.

Intensification.—The positive, if too thin, may be intensified either with the usual pyro and silver intensifier or with bichloride of mercury.

Success with this method depends on the quality of the negative and the complete washing away, after the exposure to diffused light, of all the free silver.

Reversed negatives obtained by exposure through the glass are, after development and drying the backs, exposed to diffused light through the glass in the plate-holder.

Without this precaution there is danger of fog, unless all the iodide of silver acted upon by light was reduced by the developer and the intensifier.

CHAPTER XXII.

OBERNETTER'S METHOD FOR THE DIRECT PRODUCTION OF NEGATIVES FROM NEGATIVES.

In the "American Annual of Photography for 1887," the late E. Obernetter described a practical method for the reproduction of negatives in any size.

In the issue of the "Annual for 1888," Herr F. Mueller gives a few valuable notes on the process.

Both of these papers have been freely drawn upon in the following description, which has been written only after a thorough trial of the method, which has demonstrated its practical utility. This test of the process was the more severe, since the negatives thus reproduced were in many cases very far from possessing that high degree of technical excellence which is to be desired in negatives which are reproduced.

The first requisite to complete success is faultless negatives of moderate density. The next is that the plates on which the reproduced negatives are made be thinly but evenly coated with an emulsion containing a comparatively small percentage of gelatine.

Evenness of coating is greatly assisted by using plate or patent plate glass.

The negative to be reproduced is placed in the copying camera, with the film side turned away from the lens, and focused to the desired dimensions, and the sensitive plate exposed for a considerably longer time than would be necessary for the production of a good positive, and developed with the usual oxalate of iron developer till the positive image is distinctly visible at the back of the plate.

If the exposure was sufficiently prolonged, the image flashes up at once, the plate blackens quickly, and the development is completed within two minutes.

It is important that both sides of the plate appear black, with only faint indications of the high lights. Unless this is the case the reproduced negative will fail to give the fine details and gradations of the original.

When fully developed, the plate is well washed, and then immersed in the following chromic solution till the black deposit has completely changed to white:

Water	35 ounces
Bichromate of potassium	1540 grains
Nitric acid (c. p.)	17½ ounces

For use, the solution is diluted with water in the proportion of 1 to 15.

Three or four minutes' immersion in this bath will be required to produce a thorough change of color.

When the change is complete, the plate is thoroughly washed, and then made sensitive by pouring over it repeatedly, and flowing, from corner to corner, the following solution:

Water	35 ounces
Ammonia	6 drams
Bromide of ammonium	308 grains

The plate is again washed, and exposed to diffused daylight for a length of time varying from one to six seconds, according to the sensitiveness of the plate and the intensity of the light.

After this second exposure, the plate is re-developed with the developer used for the first development.

The negative will develop slowly with every appearance of being under-exposed. But if the second exposure was sufficiently prolonged density will gradually increase to the desired degree. If, however, the time of exposure was too short, the negative will refuse to gain in strength.

The plate is fixed in the usual hypo solution, well washed, treated with dilute hydrochloric acid to clear up the shadows, and finally washed again to remove all traces of the acid.

INDEX.

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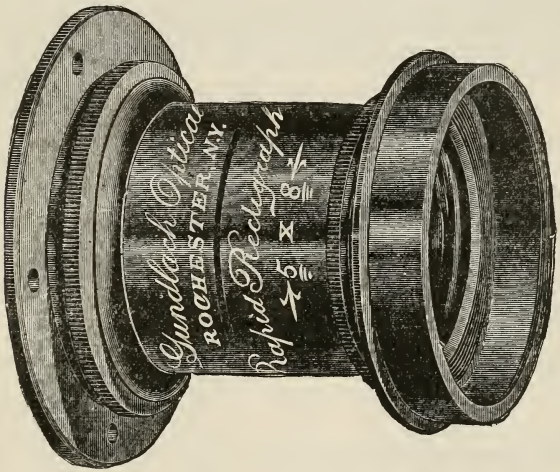

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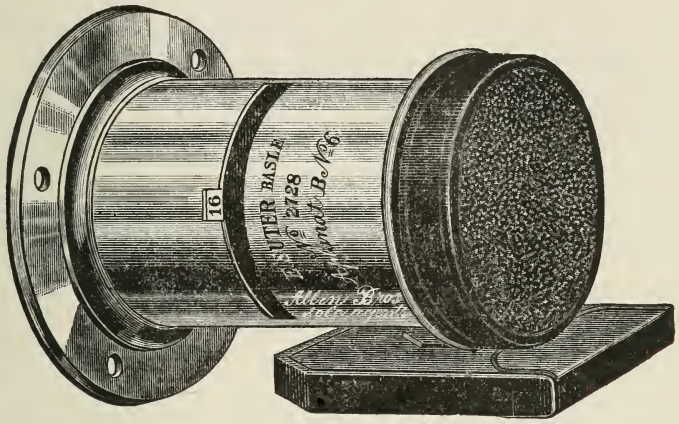

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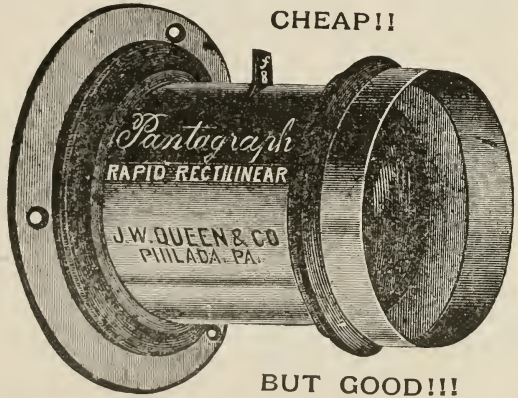

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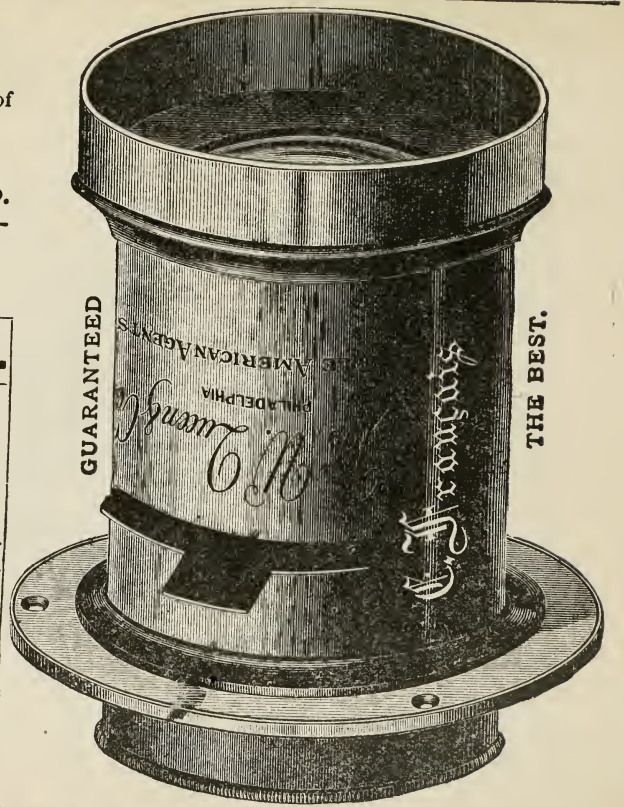

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